TWENTY-FIRST ILLINOIS CUSTOM SPRAY OPERATORS TRAINING SCHOOL

SUMMARIES OF PRESENTATIONS
JANUARY 22 & 23, 1969
URBANA, ILLINOIS

Cooperative Extension Service
University of Illinois
College of Agriculture, Urbana,
in cooperation with the
Illinois Natural History Survey

This training school is presented specifically for commercial applicators of agricultural chemicals by the University of Illinois College of Agriculture, Agricultural Extension Service, and Illinois Natural History Survey, but is open to all persons involved in the handling of agricultural chemicals. The school promotes the proper, timely, and wise use of agricultural chemicals. We gratefully acknowledge the assistance of officers of the Illinois Association of Aerial Applicators and the Agricultural Spraying Association in planning the program. Abstracts in this manual bring to you the latest research information, but do not constitute positive recommendation unless so stated. Statements made herein are the responsibility of either the speaker or the institution he represents.

1969 PESTICIDE DEALERS' AND APPLICATORS' CLINICS

As a pesticide dealer or applicator, we invite you to attend one of the area agricultural chemical clinics. The discussions will include the current situation and the why and how of control for weeds, diseases, and insects affecting field crops, as well as the proper use of application equipment. Examination for the Custom Spray Operators' License will be given at the end of the meeting.

We look forward to seeing you at the meeting and discussing problems of mutual interest. These are the dates and locations for the clinics:

DATE	*CITY*	*LOCATION*
February 18	Joliet	Rossi Autumn Acres Restaurant (Southeast corner, Junction 66 and 52)
February 19	Dixon	Lincoln Manor Restaurant
February 20	Galesburg	Holiday Inn
February 21	Bloomington	Sinorak Restaurant (Junction 51 & 66, south edge of city)
February 25	Effingham	Ramada Inn
February 26	Benton	Holiday Inn
February 27	Belleville	Augustine's Restaurant (Sun Room)
February 28	Jacksonville	Black Hawk Restaurant

A registration of $2 per person will be charged to cover the cost of the reference packet and other incidental expenses.

The program for the clinics is shown on the next page.

9:30 a.m.

Registration and Get Acquainted

9:55 a.m.

PROGRAM

9:55-10:00	Welcome.	*Extension Adviser*
10:00-10:20	Things You Ought to Know About Corn Borer for 1969 . . .	*Steve Moore*
10:20-10:40	Field Crop-Disease Control Experiments on Northern Corn-Leaf Blight, Corn Rootworms--Root Rot Interactions and the Soybean Cyst Nematode.	*Mike Britton*
10:40-11:00	Recognizing and Reducing Herbicide Injury to Crops	*Marshal McGlamery*
11:00-11:30	Keeping Up-to-Date on Corn Rootworms, Seed Corn Beetles, and Other Soil Insects (Joliet, Dixon, Galesburg, and Bloomington)	
	<u>or</u>	
	The Seed-Corn Beetle Problem and Planning a Corn Soil-Insect Control Program for Your Customer (Effingham, Benton, Belleville, and Jacksonville). . . .	*Pete Petty*
11:30-12:00	Pesticide Spray Equipment.	*John Siemens*

12:00 noon-1:00 p.m.

LUNCH

1:00- 1:10	The Illinois Custom Spray Operators Licensing Law. .	*Juett Hogancamp*
1:10- 1:30	Questions and Answers on Corn Leaf Aphids (Joliet, Dixon, Galesburg, Bloomington, and Jacksonville)	
	<u>or</u>	
	What Is Happening to the Alfalfa Weevil? (Effingham, Benton, and Belleville)	*Pete Petty*
1:30- 1:50	Herbicide Use Patterns and Trends in Illinois. . .	*Marshal McGlamery*
1:50- 2:20	The Field-Crop Disease Situation	*Mike Britton*
2:20- 2:40	Knowing and Controlling Barn and Pasture Flies	*Steve Moore*
2:40- 3:00	What's New in Weed Control	*Marshal McGlamery*
3:00- 4:00	Examination for the Custom Spray Operators' License will be given by Mr. Juett Hogancamp of the State Department of Agriculture.	

Prepared by the Pesticide Dealers and Applicators Committee

1969 SMALL-PACKAGE DEALER CLINICS

Many of you have attended one of our Pesticide Dealers' Clinics where information about agricultural pesticides was discussed. In 1969, there will be a similar series of clinics as well as a series primarily for the nonagricultural or small-package dealer. Other dealers are welcome to attend. Specialists from plant pathology, horticulture, and entomology will appear on the program. These are the dates, locations, and program for the clinics:

DATE	*TIME*	*CITY*	*LOCATION*
February 4	9:30 a.m.	Homewood*	Dixie Governor Motor Inn 175th and Dixie Highway
February 5	9:30 a.m.	Arlington Heights*	Rolling Meadows Holiday Inn Junction of 62 and 53
February 7	10:00 a.m.	Springfield	Heritage House South US 66
February 18	6:00 p.m.	Moline*	The Plantation 3701 7th Street

* The Program at these meetings will include topics on herbicides, insecticides, and fungicides sold to homeowners for controlling weeds, insects, and diseases. There is an advance registration fee for the clinics at Moline, Homewood, and Arlington Heights. For more information on the clinic at Moline, contact J.E. Kenney, Extension Adviser, 1188 Coaltown Road, East Moline, who is in charge of advance registration. Contact William Whiteside, Cook County Extension Adviser, who is in charge of advance registration for the clinics at Homewood and Arlington Heights.

Small-Package Dealer Clinic Committee:

Mal Shurtleff — Stanley Rachesky
Herb Hopen — Roscoe Randell

1969 DEALER AND APPLICATOR FIELD DAYS

ALFALFA WEEVIL:

April 2	Dixon Springs	April 22	Greene County
8	Randolph County	23	Macon County
15	Monroe County	29	Iroquois County
16	Madison County		
		May 6	Grundy County

EUROPEAN CORN BORER:

May 24	Pulaski-Alex. County	June 17	Brown County
25	Saline County	17	Henderson County
		18	Knox County
June 3	Perry County	18	McLean County
4	White County	19	Livingston County
9	Jasper County	19	Iroquois County
10	St. Clair County	23	Whiteside County
10	Marion County	23	LaSalle County
11	Macoupin County	24	JoDaviess County
11	Moultrie County	24	Winnebago County

CORN ROOTWORM AND CORN LEAF APHID:

July 15, 16, and 17--to be scheduled.

These field meetings will be primarily for dealers and applicators but others interested in proper pesticide sales and applications are invited. The meeting will be conducted by entomologists; a plant pathologist will also be in attendance at some of them. The meetings will be from 1:30 to 3:30 p.m. They will start in the University of Illinois County Extension Adviser's office. We will go to the field from there. Contact your county Extension adviser for more information.

FORMAL PROGRAM

Illini Union Building, Illini Room
Wednesday Morning, January 22, 1969

RICHARD RITENOUR, PRESIDING

8:30-
9:30 a.m. Colored Slides. . . . . *Staff*

Pesticide Safety--Where and What. . . . . *Roscoe Randell*

Specific Weed Problems. *F.W. Slife*

Climbing Milkweed Control . . . . *Harold Coble*
Panicum in Illinois . . . . *John Houghton*
The Effect of Environment on
Atrazine Postemergence. . . . . *Fate Thompson*
Nutgrass Control. . . . . *Larry Wachtel*
Atrazine-Sutan Combinations . . . . *Tom Threewitt*

Pasture Fly Populations on Cattle . . . . *Steve Moore*

EARL GROSSMAN, PRESIDING

The 1969 Insect Situation . . . . *Don Kuhlman and Stephen Sturgeon*

Control of Northern Corn Leaf Blight With
Fungicides. . . . . *M.P. Britton*

Changes in Illinois Insecticide Use Suggestions . . . . . *H.B. Petty*

What Happens to Phosphate and Carbamate Insecticides
in the Total Environment. . . . . *R.L. Metcalf*

Corn Leaf Aphids and Corn Yields. . . . . *Roscoe Randell*

Weed Control in No-Tillage Corn . . . . *Ellery Knake*

12:30 Lunch

DEAN ROY, PRESIDING

1:30 p.m. Soybean Cyst Nematode Research Results. . . . . *Dale Edwards*

Behavior of Insecticides in Soil. . . . . *C.R. Harris*

2,4-D Injury to Corn. *F.W. Slife*

Why Chemicals Fail to Control Cutworms. . . . .*C.R. Harris*

The Garden Symphylan--A Potential Corn Root Pest. . . *R.E. Sechriest*

Early Post and Directed Herbicide Sprays
for Soybeans. . . . . *Robert Frans*

3:25 Coffee

ROLAND MACY, PRESIDING

3:45 Effect of 2,4-D, Dicamba, and Tordon on Soybeans. . . . . .*Lloyd Wax*

Incorporation of Granular Materials . . . .*B.J. Butler*

Herbicides for Soybeans. . . . .*M.D. McGlamery*

Review of European Corn Borer Control. . . . . *W.H. Luckmann*

Weed Control Programs for Corn . . . .*Ellery Knake*

5:10 Adjourn

THURSDAY MORNING, JANUARY 23, 1969
VERNON ANDERSON, PRESIDING

8:45 Herbicides for Gardens. *Herb Hopen*

Extent of Damage by the Common Stalk Borer. . . . . *Stephen Sturgeon*

New Factors in Alfalfa Weevil Control . . . .*Ed Armbrust*

A Report on New Fungicides. . . . . *M.C. Shurtleff*

Soil Color Charts for Estimating Organic Matter . . . *John Alexander*

New Herbicides. . . . . *M.D. McGlamery*

Water Weed Control. . . . . *R.C. Hiltibran*

10:25 Coffee break

EARL THOMPSON, PRESIDING

10:45 Low-Volume Herbicide Applicators. . . . . *J.C. Siemens*

Seed-Corn Maggot Resistance to Aldrin and Heptachlor. . .*C.R. Harris*

Resistant Seed-Corn Beetles in Illinois . . . .*Steve Moore*

Corn Rootworm Adult Populations . . . . *Don Kuhlman*

Corn Rootworm Demonstration Plot Results. . . . . *H.B. Petty and Don Kuhlman*

Corn Rootworm Control--New Techniques and New Insecticides. . . . . *R.E. Sechriest*

The Relationship of Root Rot, Rootworms, Fungicides, and Insecticides. . . . . *M.P. Britton and Wayne Howe*

Atrazine and Additives as Postemergence Treatments. . . . *F.W. Slife*

12:40 Adjourn

TABLE OF CONTENTS

PESTICIDE SAFETY--WHERE AND WHAT

ROSCOE RANDELL

PESTICIDE INGESTION ACCIDENTS

If any child under 12 years of age in this state ingests or is contaminated with a hazardous substance, one of the poison-control centers is contacted. Then, the case is reported to the Illinois Department of Public Health. A major part of this report is a summary of these cases.

We have been summarizing this information since 1960. Dr. Norman Rose, Bureau of Hazardous Substances and Poison Control, Illinois Department of Public Health, Springfield, provides us with the information on the pesticide ingestion cases annually.

During the past eight-year period, a yearly average of 11,346 children (12 years and under) either ate or were exposed to a hazardous substance (Table 2). Accidental ingestion of medicines makes up the largest number of cases reported each year, with an average of almost 60 percent (Table 1).

Table 1 also shows that the ingestion of pesticides has accounted for an average of 6.6 percent during the last eight years, declining from 8 percent in 1960 to 5.3 percent in 1967. The number of pesticide cases reported each year has remained about the same, but the percentage has dropped. The reasons for this are (1) the population has increased each year and (2) since 1960, more parents have developed an increased awareness of the hazards involved in the accidental ingestion of medicine. Parents have been more willing to take their children to their doctor or a poison-control center after an accidental ingestion than in previous years.

In Table 2, we can observe that accident cases fluctuate throughout the year, with more children eating pesticides and paint from the late spring to late fall than at other times. The peak time for eating medicines is in the winter, while that for ingesting household preparations is in the fall. Summarizing pesticide ingestions by seasonal variations (Table 3), we see that rodent-bait ingestion occurs most often in November and December. Ant bait ingestions are most common from May through August. Roach bait ingestions are highest in the fall months. Mothball ingestions do not seem to have any peak periods during the year.

Pesticides intended for the control of rodents, ants, moths, and roaches made up about 82 percent of the accidental pesticide cases during the past eight years (Table 4). In more than half the cases, the pesticide ingested by the child was a bait.

Anticoagulant rodenticides made up the largest group of accidental ingestions. The next most common ones were the arsenicals, followed by naphthalene and PDB (Table 5).

Pesticide ingestions can be arranged into four groups: (1) those found by the child while the pesticide obtained was in use as a bait; (2) mothballs; (3) those involving improper storage; and (4) those resulting from improper disposal (Table 6). During 1967, there were 491 pesticide accident cases in downstate Illinois, with 470 resulting from the use of baits, 120 cases due to the improper use of mothballs, 80 because of improper storage, and 36 because of improper disposal.

A FOUR-STEP PROTECTION PROGRAM

The following four-step program will help to protect children from poisoning:

1. Use baits properly--out of the reach of children.

2. Store woolens properly--in sealed containers if you use mothballs.

3. Keep pesticides stored under lock and key.

4. Burn empty paper pesticide bags, and stay out of the smoke. Burn out or wash out other pesticide containers. Then, haul them to the sanitary land fill or bury them.

PESTICIDE ACCIDENTAL DEATHS

In 1967, there were no recorded deaths due to the ingestion of pesticides or from contamination by them. Since 1960, there have been 22 deaths due to pesticides, 13 involving insecticides, 5 with rodenticides, and 4 due to herbicides. Only one death was the result of an agricultural accident. Of these 22 deaths, 9 were from baits, 9 persons were affected by the pesticide while it was being used, and 7 obtained it from storage.

Twenty-two deaths (none in 1967) is a very small percentage of total number of accidental deaths, but the same causes listed for accidental ingestions were responsible for these deaths. These are, again: (1) the use of baits; (2) careless use, storage, and disposal of mothballs; (3) improper storage; and (4) improper disposal.

Table 1. Ingestion of Hazardous Materials by Illinois Children Under 12 Years of Age, as Reported to Illinois Poison Control Centers, 1960 Through 1967

	Percent of total								
Material	1960	1961	1962	1963	1964	1965	1966	1967	Average
Medicine	57.0	56.4	57.2	56.2	59.3	63.4	64.2	64.5	59.8
Household preparations	15.0	16.4	16.6	16.3	15.0	13.0	12.5	12.2	14.6
Pesticides	8.0	7.2	7.3	6.9	6.7	6.1	5.7	5.3	6.6
Paints, etc.	4.8	5.3	4.9	6.3	5.0	4.6	4.6	4.2	5.0
Cosmetics	2.4	2.7	2.7	3.0	3.0	2.7	2.8	2.3	2.7
Miscellaneous	12.8	12.0	11.3	11.3	11.0	11.2	10.2	11.5	11.4

Table 2. Ingestion of Hazardous Materials by Children Under 12 Years of Age, As Reported to Poison Control Centers. From Average Yearly Cases, 1960 Through 1967

	Bimonthly averages						
Material	Jan.-Feb.	March-April	May-June	July-August	Sept.-Oct.	Nov.-Dec.	Total
Medicine	1,102	1,161	1,007	911	1,237	1,300	6,718
Household preparations	211	242	266	283	302	274	1,578
Pesticides	75	79	140	163	149	119	725
Paints, etc.	53	68	94	123	125	87	550
Cosmetics	42	53	57	48	63	56	319
Miscellaneous	..	..	..	..	..	..	1,456
						TOTAL	11,346

Table 3. Ingestion of Pesticides Intended for Control of Rodents, Ants, Moths, and Roaches by Children Under 12 Years of Age, as Reported to Downstate Illinois Poison Control Centers. Average for 1960 Through 1967

Pests	Bimonthly total					
	Jan.-Feb.	March-April	May-June	July-August	Sept.-Oct.	Nov.-Dec.
Rodents	22	21	27	21	26	39
Ants	5	5	27	38	16	5
Moths	12	9	18	13	16	15
Roaches	5	8	8	9	13	9

Table 4. Ingestion of Pesticides by Children Under 12 Years of Age, as Reported by Downstate Poison Control Centers. Average for 1960 Through 1967. Based on Pests to Be Controlled and the Source of the Pesticide

Pests	In use	From storage	Unknown	Total	Pct. of total	Pesticide obtained as bait	Pct. of total
Rodents	76	17	63	156	33.2	149	95.5
Ants	50	7	35	92	19.6	85	92.4
Moths	46	9	30	85	18.1	0	0
Roaches	27	9	17	53	11.3	31	58.5
Unspecified	6	9	12	27	5.7	1	3.7
Flies	4	5	6	15	3.2	4	2.7
Mosquitoes	1	5	3	9	1.9	0	0
Flower pests	2	4	3	9	1.9	0	0
Weeds	4	6	6	16	3.4	0	0
Others	2	3	3	8	1.7	1	12.5
TOTAL	218	74	178	470	100	271	..
PERCENT	46.4	15.7	37.9	..	100	..	58.8

Table 5. Cases of Pesticide Ingestion by Children Under 12 Years of Age, as Reported by Downstate Poison Control Centers. 1968 Through 1967, and Total

Pesticide	Number of cases					
	1963	1964	1965	1966	1967	5-year total
Anticoagulant rodenticides	128	184	169	144	162	787
Naphthalene & PDB	93	90	101	78	85	447
Arsenicals	110	145	117	134	110	616
Unspecified	38	9	38	14	8	107
DDT	22	10	12	9	4	57
Chlordane	8	9	7	9	9	42
DDVP	2	2	1	2	3	10
2,4-D	4	7	3	9	12	35
Lindane	11	11	13	11	12	58
Strychnine	7	5	5	6	3	26
Dieldrin	6	15	3	15	19	58
Sodium fluoride	7	4	8	3	3	25
Thallium sulfate	5	10	10	13	2	40
Phosphorous paste	15	3	6	4	5	33
Pyrethrins	0	2	16	12	13	43
612 and Deet	9	11	4	6	14	44

Pesticide	Number of cases					
	1963	1964	1965	1966	1967	5-year total
Boric acid	6	5	11	7	16	45
Diazinon	1	1	1	4	1	8
Ronnel	0	1	0	0	0	1
Rotenone	0	0	2	1	0	3
Malathion	1	4	3	7	2	17
Nicotine	0	0	2	..	2	4
Methoxychlor	0	2	0	4	1	7
Aldrin	1	0	0	..	0	1
Potassium cyanate	1	1	0	..	1	3
Fungicides	0	0	3	..	2	5
Fumigants	0	0	1	..	1	2
Randox	1	0	0	1	0	2
Dimite	1	0	0	..	0	1
Parathion	0	1	0	..	1	2
Bidrin	..	..	..	1	0	1
Dibrom	..	..	..	1	0	1
TOTAL	477	532	536	495	491	2,531

Table 6. Actual and Projected Cases of Pesticide Contamination or Ingestion by Illinois Children Under 12 Years of Age, by Source of or Reason for Exposure, as Reported to Illinois Poison Control Centers

Sources	1963 Down-state	1963 Chi-cago	1963 Total	1964 Down-state	1964 Chi-cago	1964 Total	1965 Down-state1/	1965 Chi-cago1/	1965 Total
Baits	302	184	486	366	194	560	322	202	524
Mothballs	95	58	153	90	48	138	99	60	159
Storage	46	28	74	65	35	100	45	30	75
Disposal	5	5	10	17	9	26	9	7	16
Unknown	61	35	96	16	8	24	61	37	98
TOTAL CASES	509	310	819	554	294	848	536	336	872

1/ The downstate cases are actual figures. Complete Chicago totals are not available, but are projected from Chicago pesticide cases and the percentage of downstate cases.

Sources	1966 Down-state1/	1966 Chi-cago2/	1966 Total	1967 Down-state1/	1967 Chi-cago1/	1967 Total	5-year total	Yearly av.	Percent total
Baits	275	186	461	271	199	470	2,501	500	60.7
Mothballs	80	33	113	85	35	120	683	137	16.6
Storage	29	15	44	63	17	80	373	75	9.1
Disposal	15	6	21	29	7	36	109	22	2.7
Unknown	96	45	141	43	49	92	451	90	10.9
TOTAL CASES	495	285	780	491	307	798	4,117	824	100.0

1/ Downstate cases are actual figures. Complete Chicago totals are not available, but are projected from Chicago pesticide cases and the percentage of downstate cases.
2/ Actual Chicago figures.

Table 7. Accidental Deaths, Illinois, 1960, 1961, 1962, 1963, 1964, 1965, 1966, and 1967

Cause or location	1960	1961	1962	1963	1964	1965	1966	1967	8-year average	Percent of total
Motor vehicles	1,741	1,843	1,890	2,019	2,205	2,261	2,535	2,490	2,123	45.0
Home accidents	1,270	1,204	1,286	1,380	1,338	1,260	1,430	1,432	1,325	28.1
Public accidents	874	923	892	855	892	918	1,084	1,056	937	19.9
Occupational accidents	318	331	303	312	316	374	346	363	333	7.0
TOTAL	4,203	4,301	4,371	4,566	4,751	4,813	5,395	5,341	4,718	
Fires-explosions	362	338	357	442	379	394	474	408	394	8.4
Falls on stairs	136	136	125	106	143	137	121	134	130	2.8
Firearms	100	92	117	100	109	105	116	138	110	2.3
Drugs, etc.	49	70	81	98	86	101	117	60	83	1.8
Barbiturates, etc.	21	29	39	54	39	41	54	62	42	0.89
Lead	28	16	26	19	8	18	7	14	17	0.36
Aspirin, etc.	12	11	13	11	10	16	11	8	12	0.25
Other animals	2	7	6	4	5	3	4	3	4.3	0.091
Lightning	4	5	2	4	2	4	2	3	3.2	0.068
Petroleum products	0	5	2	3	0	0	1	0	1.4	0.030
Insecticides	5	1	0	1	0	3	3	0	1.6	0.034
Rodenticides	2	0	1	0	0	1	1	0	0.6	0.0127
Herbicides	0	1	0	0	1	0	2	0	0.5	0.0105
Venomous stings, etc.	2	0	0	0	1	3	1	0	0.9	0.0191
Arsenic	1	1	0	0	0	1	4	0	0.9	0.0191

Source: Illinois Department of Public Health, Bureau of Vital Statistics, Springfield, Illinois, from Tables of Accidental Deaths Occurring in Illinois, by Causes of Death and Nature of Injury, as supplied by Clyde Bridger, Chief Statistician.

CLIMBING MILKWEED CONTROL

HAROLD COBLE

Milkweeds are among the most common plants found in all parts of the world. Over 2,000 different species of milkweed have been recorded. In Illinois, 13 kinds of milkweed can be found; of these, only 3 are considered serious weeds: common milkweed, whorled milkweed, and climbing milkweed. Whorled milkweed is usually found in permanent pastures and noncultivated areas. Common milkweed and climbing milkweed are found in the same places, but are also found in cultivated crops. During the past ten years, climbing milkweed has increased rapidly in cultivated areas. Because of its climbing growth habit, it is a more serious problem than common milkweed. Climbing milkweed interferes with harvest and in some cases actually pulls corn down before harvest time.

CONTROL EFFORTS

Attempts to control milkweed with 2,4-D or other selective chemicals have been unsuccessful, but 2,4-D or similar materials have affected the plant to some extent, indicating that it is not completely tolerant.

During 1968, 2,4-D, 2,4,5-T, dicamba, picloram, and combinations of these chemicals were applied as foliage sprays to climbing milkweed in the early bloom stage. Some of these treatments were effective in eliminating top growth and at least part of the root system. No regrowth occurred during late summer or fall. Treatments were applied at the early bloom stage, with the thought that food manufactured in the leaves would be moving into the root system for storage and that the herbicides would move with these food substances. Treatment of Canada thistle and wild sweet potato has been more successful in the bud stage than when treatments have been applied earlier. Our preliminary results with climbing milkweed appear similar. Applications of various chemicals will be continued in 1969, in order to determine the best rate and time of treatment.

FUTURE OUTLOOK

If our work is successful and a treatment at the bud or early bloom stage is required, considerable difficulties still lie ahead. Climbing milkweed does not bloom until late summer, and in some cases the corn may be reaching maturity. Treatments at such time would be difficult, because of the need for high-clearance equipment or perhaps application from the air. Since the milkweed would have considerable growth by then, coverage would also be difficult. An even greater difficulty concerns FDA clearance of compounds for use on corn at this stage of growth.

Our major objective is to find the system of control first. We are hopeful that the other problems can be worked out.

Although we will be concerned primarily with climbing milkweed, we believe that the data will also apply to the other milkweed problems.

PANICUM CONTROL

JOHN HOUGHTON

During the past five years various panicum species have increased in Illinois. In 1968, these plants were a major weed problem in some fields. The panicums are not new weeds; they have been in Illinois and in the United States for many years. Although there are 35 different kinds of panicum in Illinois, we are concerned only with the ones that grow in cultivated areas. These types are vigorous annuals, generally called fall panicum or witchgrass.

LOCATION AND SENSITIVITY

In corn or soybean fields the panicums are seldom found where other weed growth is vigorous. On the contrary, they are usually found in fields where other annual weeds have been well controlled.

Panicums are apparently sensitive to herbicides to the same degree as are other annual grasses. Preplant or preemergence treatments for grasses seem to give excellent control in the early part of the season. In this respect, they are similar to crabgrass.

1968 AND 1969 PLANS

At the Agronomy Farm in 1968, herbicides were applied to corn as early as April 24. This was followed by a month of cold, wet weather. In addition, the rainfall for the month of June was above normal. Weed control was excellent for about eight weeks under these conditions, but by late June there was not enough herbicide residue to kill new panicum seedlings. The result was a heavy infestation of this annual grass. Since the corn was approximately 3 feet tall by the time the panicum plants germinated, yields were probably not affected very much. However, the panicum plants did interfere with combine harvest, and this may turn out to be the greatest problem.

Our studies on panicum in 1969 will include:

1. Effect on corn yield.
2. Corn row spacing.
3. Tall versus short corn hybrids.
4. Corn cultivation versus no cultivation.
5. Evaluation of chemicals for control.

WHAT TO EXPECT IN THE FUTURE

It seems logical that panicum will be more common in the future, simply because we have done such an excellent job of controlling other weeds. It is also logical that prevalence in a particular year will depend on the time of corn planting, water stress on the herbicides used, and seasonal rainfall patterns. We can expect more panicum in years when planting is early, when there is above-normal rainfall after planting, and when there is enough rainfall during the summer for panicum to grow vigorously.

ATRAZINE AS A POSTEMERGENCE SPRAY

FATE THOMPSON

The use of atrazine as a postemergence spray for corn has increased rapidly in recent years. Although atrazine was known to have postemergence activity, it was not used on substantial acreage until additives were used with it. Reports from all over the United States and Canada indicate that this treatment is exceptionally good on broad-leaved weeds in corn, but that the control of annual grasses is variable. The control of giant foxtail has been particularly variable, with results ranging from complete control to very poor control.

RESEARCH BACKGROUND

The purpose of my research problem was to study the environmental factors that affect the control of giant foxtail with atrazine applied as a postemergence spray. Some of the studies reported here were done in the field; others, in the greenhouse and growth chambers.

It has been known for some time that atrazine does not move in the phloem of the plant and that its movement is restricted to the xylem. Atrazine applied preemergence or preplant (incorporated) is extremely effective because it is absorbed, and then it moves via the xylem into all parts of the plant. When atrazine is applied to the leaf of giant foxtail, we would expect it to affect that leaf, but not to move into the stem. For atrazine to be effective in killing giant foxtail, therefore, we thought it would have to be absorbed from the lower stem area or from the root system.

To test the above hypothesis, a series of experiments was initiated.

EFFECT OF HUMIDITY AND OF REWETTING THE FOLIAGE

Foxtail plants were sprayed with atrazine plus an additive in 20 gallons of spray per acre. In one experiment, half of the treated plants were exposed to high humidity for several hours after application; in another, half of the treated plants were rewetted. The high humidity and wet foliage are similar to conditions at night in the Corn Belt (high relative humidity and heavy dews). The plants that were exposed to high humidity or rewetted had complete leaf kill, but the treated plants growing under low humidity (and not rewetted) had much less leaf kill. Thus, it seemed that much more atrazine penetrated the leaves exposed to high humidity or rewetted after the application. However, all plants regenerated new leaves.

To substantiate the above observations, atrazine was applied to corn leaves in a series of very small droplets. These droplets were similar to those observed from a normal spray pattern. Part of one group of treated plants was exposed to high humidity and another part to low humidity. Part of a second group was rewetted after treatment and another part was kept dry. The leaves were washed later, and the amount of atrazine washed from the leaves was determined. The high-humidity and rewetting treatments greatly increased the amount of atrazine moving into the leaf.

EFFECT OF SPRAY VOLUME

We thought that increasing plant coverage might increase the activity of the treatment by allowing absorption into the stem. Atrazine plus an additive was applied to foxtail in 20, 40, and 80 gallons of spray mixture per acre, but none of the volumes applied killed the foxtail plants. New growth was soon initiated.

EFFECT OF RAINFALL

In both greenhouse and field studies, simulated rainfall was applied soon after the atrazine treatment, resulting in excellent kill. It was most effective where the soil had been wet earlier, least effective where rainfall was applied to treated foxtail growing in relatively dry soil.

This work indicated that root absorption was involved in the control of foxtail with postemergence atrazine treatments. To study this effect further, the soil was covered with a paraffin layer so that rainfall after treatment was not allowed to leach atrazine into the root zone. In this case, excellent leaf destruction resulted, but the plants were not killed. When the soil was not covered with paraffin, adding rainfall after treatment was slightly more effective in killing those plants that were grown on soils that had been frequently watered before treatment. The reason for this seems to be that the root system of foxtail, which in always initiated near the soil surface, is even closer to that surface under wet conditions than dry ones.

These results, in the laboratory and in field, have led us to believe that giant foxtail is sensitive to postemergence atrazine when rainfall follows soon after treatment. The plants are killed by some atrazine being taken up by the leaves and then by additional atrazine being taken up by the root system.

Oils or surfactants are of great benefit. They increase leaf penetration and, in addition, may be important in helping move unused atrazine on the leaf to the base of the plant where it can be absorbed.

Even though foxtail plants may not be killed when there is no rain soon after treatment, the plants will be much easier to cover up with cultivation if the humidity has been high enough to result in good leaf penetration.

NUTGRASS CONTROL

LARRY WACHTEL

During the past twenty years, considerable emphasis has been placed on the control of perennial weeds in crop land. We have been concerned with the control of three perennials in Illinois: Canada thistle, quackgrass, and Johnsongrass. Control programs are available for these pests, and considerable headway has been made in reducing the area of infestation.

BACKGROUND INFORMATION

The development of better, annual weed control through the use of herbicides appears to have made the presence of other perennial weeds more noticeable. One of these is nutgrass. A minor problem in Illinois for many years, it is now spreading rapidly. Control measures must be initiated in order to prevent it from spreading further. Our particular problem is northern nutgrass *(Cyprus esculentus)*. This plant is considered a perennial, but for all practical purposes it acts like an annual. It reproduces by forming nutlets in the soil. These nutlets are the source of new plants in the spring. Although nutgrass will produce some seed, the formation of new nutlets seems to be the major method of spreading the infestation.

1968 STUDIES

In 1968, we followed the development of nutgrass germinating from nutlets. We found that the young plant is very similar to an annual grass plant in that the permanent root system forms near the surface of the soil soon after it emerges. In three weeks, the permanent root system is producing rhizomes, which usually come to the surface and produce more plants. Each new shoot that emerges also forms a permanent root system; this, in turn, produces more rhizomes. In the early part of the season, the rhizomes generally turn up and form new plants, but when the days begin to shorten, the rhizomes stay underground and produce nutlets for the next season.

We found nutlet formation on plants that had emerged six weeks earlier. Nutlet formation seems to be continuous throughout the summer, depending on growing conditions. In some of our test plants, 500 nutlets were formed from a single plant during one season.

RESULTS

These studies on the development of nutgrass have indicated that there can be two approaches to control. One is to kill the nutlets as they germinate by a soil-incorporated treatment. The other is to apply postemergence treatments to the young shoots so that the permanent root system will not form.

In a series of greenhouse experiments, we found that some soil-incorporated treatments were effective in preventing growth from the nutlets. Eptam was the most effective, followed by Sutan and Lasso. Ramrod was partially effective. Atrazine had the least effect.

On the basis of the greenhouse data, we chose to use 2 pounds of Lasso and 4 pounds of Sutan in the field. These were incorporated into the soil, and very small nutgrass plants were transplanted into the treated area. About one week after transplanting, we initiated a series of postemergence sprays. These were atrazine plus oil, Lorox plus a surfactant, and atrazine plus oil plus 2,4-D. These and some other treatments were applied to new plots at different times. The results indicated that the postemergence treatments applied early were more effective, particularly if rain fell soon after application. The soil treatments alone inhibited nutgrass, but did not completely eliminate it. Several of the combination preplant and postemergence treatments gave 100-percent elimination.

Work will be continued on this project in 1969.

SUTAN-ATRAZINE COMBINATIONS

TOM THREEWITT

Interest in preplant herbicides for corn has grown in recent years, and an increasing amount of corn acreage has been treated in this manner. Although preplant herbicides cost more per acre than band treatments at planting time, they may be more convenient to apply. For example, they can be applied with liquid nitrogen or insecticide prior to planting, and hence, speed up the actual corn-planting process.

In 1968, a new herbicide, Sutan, was cleared for use on corn. It performed well in a series of tests in 1967 when combined with atrazine for preplant applications. Its selectivity is toward grass weeds and hence supplements the excellent broadleaf killing properties of atrazine. This could be an advantage, particularly on heavy soils where grass control with atrazine has sometimes been difficult.

Three pounds of Sutan and 1-1/2 pounds of atrazine were applied one month ahead of planting and just before planting in 1968. These treatments were compared with atrazine at 3 pounds alone applied on the same dates. All of these treatments gave excellent control of both grasses and broad-leaved weeds for most of the growing season.

The generally accepted rate of the Sutan-atrazine combination is 3+1 or 3+1-1/2. These rates appear to be tentative until more data on performance are accumulated.

My studies in 1968 dealt with evaluating various combinations of Sutan-atrazine, determining the tolerance of several inbreds to Sutan, and determining the soil residue from Sutan treatments.

Although the 3 pounds of Sutan had performed very well with atrazine, it was decided to examine lower rates in the combinations. This was achieved by combining 0.75, 1.1, 1.5, 1.8, and 2.25 pounds of Sutan with atrazine at 1, 1.5, 2, 2.5, and 3 pounds per acre. The test was initiated on clay loam soil with about 3.5 percent organic matter.

The above combinations were applied on one series of replicated plots two weeks before planting and on another series just before planting. The treated area was heavily infested with annual grasses, particularly giant foxtail. The corn was planted in 30-inch rows, and no cultivation was used during the season. None of the treatments injured the corn, and weed control was exceptionally good on many plots. Although 3 pounds of atrazine was exceptionally good alone, some reinfestation of annual grasses occurred late in the season. Rates below 3 pounds were greatly aided by Sutan at all rates. The 2.25-pound rate of Sutan gave excellent grass control alone, and complete weed control resulted when this rate was combined with any of the rates of atrazine.

This study indicates that preplant treatments of atrazine-Sutan can give wide-spectrum weed control and under some conditions can be superior to either chemical alone.

Forty inbreds were evaluated for their tolerance to preplant applications of Sutan. Rates of 3, 4, and 5 pounds of Sutan were disked into the soil the day before the inbreds were planted. Data were taken on emergence date, stand, height, time of flowering, and yield.

Grass-weed control was excellent at all rates of application, but the plots were cultivated to control broad-leaved weeds. Crabgrass emerged during late summer on the check plots but not in the treatment area. The majority of inbreds evaluated exhibited good tolerance to Sutan even at 5 pounds per acre. Only one of the inbreds tested, A554-67-4649, was injured by the Sutan treatments. Early growth was retarded, but it recovered later. It should be pointed out that it is rather normal to have variation among inbreds in their reaction to weed chemicals. This project will be continued next year.

Separate plots were established in order to study the length of residue of Sutan in the soil. Rates of Sutan used were 2, 4, and 6 pounds per acre. Soil samples were obtained at intervals during the growing season and taken to the laboratory and extracted and the Sutan measured by gas chromatography. In addition, grain sorghum seed was planted in the plots at different intervals during the season.

The sorghum seedlings were killed at all rates of Sutan for about eight weeks. At that time, seedlings were able to survive on the plot with the 2-pound rate. By September, the growth of sorghum seedlings was normal even on plot with the 6-pound rate. These observations along with the laboratory data indicate that the residue of applied Sutan declines steadily and that it poses no problem to crops planted the following year.

FLY POPULATIONS ON PASTURED CATTLE IN ILLINOIS, MAY THROUGH SEPTEMBER, 1968

STEVENSON MOORE, III

PURPOSE

A study was undertaken to follow the population levels of the major species of flies that attack pastured cattle during the spring and summer months.

METHODS

Five observers located about 100 miles apart, north to south in the state, were trained to count flies. Side counts on ten animals in each herd were recorded. The counts were made around noon each week.

RESULTS AND DISCUSSION

Horn flies were the most numerous species attacking pastured cattle in Illinois, followed by stable flies and face flies (Table 1). The fly populations were highest during July and August.

Table 1. Fly Populations on Pastured Cattle, Illinois, 1968

	Number of flies per animal														
	May			June			July			August			September		
Location	Horn flies	Stable flies	Face flies	Horn flies	Stable flies	Face flies	Horn flies	Stable flies	Face flies	Horn flies	Stable flies	Face flies	Horn flies	Stable flies	Face flies
Southern	49.7	9.0	0	212.5	2.2	0.4	424.0	5.6	4.6	518.2	6.4	8.1	208.3	4.2	4.8
South central	24.4	3.5	0	103.2	3.2	5.0	167.3	30.1	20.8	223.3	12.8	12.4	88.3	10.2	12.9
Central	37.0	6.2	0	58.9	7.5	6.2	139.9	30.2	29.4	149.0	33.6	32.6	73.9	24.0	19.0
North central	...	...	...	41.8	0.8	3.3	80.6	1.6	5.7	83.9	3.1	6.5	83.7	3.9	7.9
Northern	...	...	...	14.2	0	8.6	74.3	0	6.1	93.3	0	17.2	73.3	0.8	3.2
State	37.0	6.2	0	91.2	3.0	4.7	177.2	13.5	13.3	213.5	11.2	15.3	98.7	6.6	8.4
State (all months)	142.6	8.4	9.9	...	...	...	...	...	...	...	...	...	...	...	...

Horn fly populations began increasing in late May, reaching their peak in early July (Figure 1) and remaining high until late August. The horn fly populations were heaviest in the southern section, becoming progressively lower in areas to the north (Figure 2).

The stable fly populations increased during June, reaching their peak by early July and holding high until late August (Figure 3). These populations were highest in herds located in the central and south-central sections (Figure 4), but only because these herds were close to heavy stable-fly breeding sites. Generally, we expected stable fly populations to follow a pattern similar to that of horn flies--highest in the south, gradually decreasing to the north.

The face fly populations increased slowly until late June, followed by a more-rapid increase. These populations were highest from late July through late August (Figure 5).

The number of face flies was highest in the central, south-central, and northern sections (Figure 6). Normally, populations are lowest in the southern third of the state (south of Route 460).

The effect of temperature on fly populations is evident in Figures 1, 3, and 5. As the mean temperatures moved above 70° F., the horn fly, stable fly, and face fly populations increased more rapidly.

Rainfall was near or above normal at all five observation points. No obvious correlation between rainfall and fly populations was apparent.

Fly populations varied only slightly on pastured cattle between 8:00 a.m. to 4:00 p.m. (Table 2).

Table 2. Fly Populations on Pastured Cattle at Different Times of Day, Illinois, 1968

	Number per animal		
Fly species	8:00 a.m.	12:00 noon	4:00 p.m.
Horn flies	176.8	180.2	171.8
Stable flies	9.9	12.2	11.4
Face flies	12.5	14.9	15.6

A conservative estimate of the production loss (weight gains or milk flow) caused by flies on pastured cattle during the 4-month fly season in Illinois in 1968 would be 10 percent (Table 3).

Table 3. Potential Production Loss From Flies Attacking Pastured Cattle, Illinois, 1968

Fly species	Percent production loss per fly per day	Number of flies per animal May-September	Percent production loss per animal
Horn flies	.02	142.6	2.9
Stable flies	.7	8.4	5.9
Face flies	.15	9.9	1.5
		TOTAL	10.3

It is obvious that insecticide treatments should begin on pastured cattle in late May in the southern sections and in early June in the northern sections, if a buildup of flies is to be prevented.

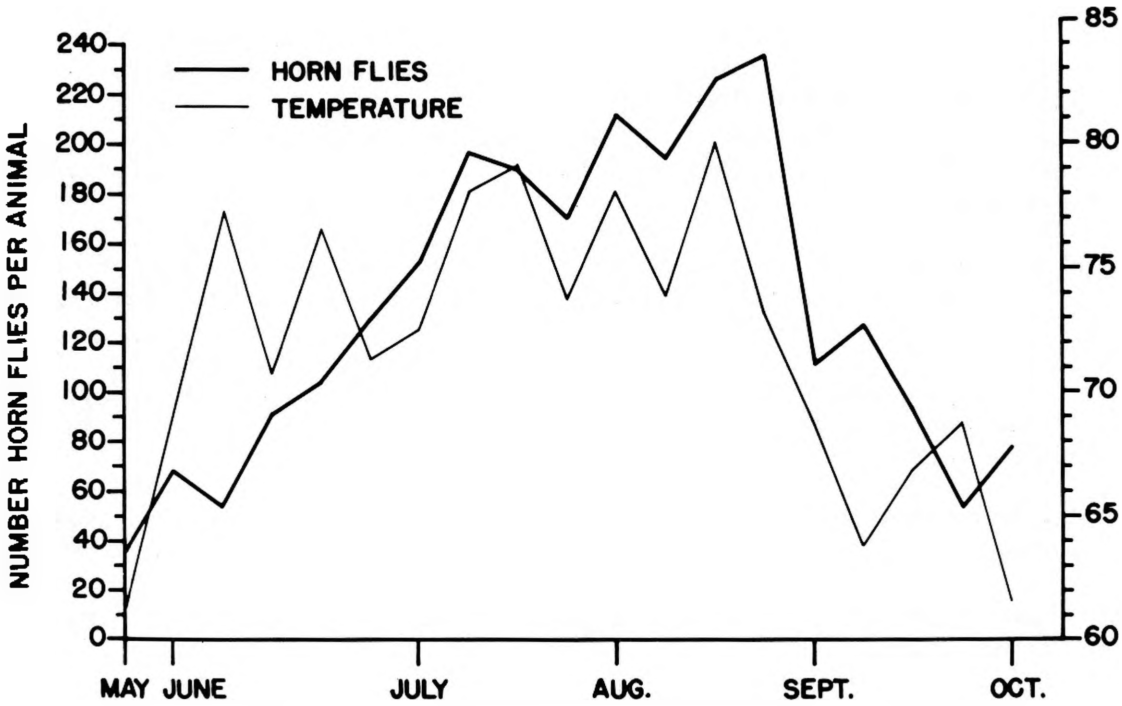

Figure 1. Horn fly populations, Illinois, 1968.

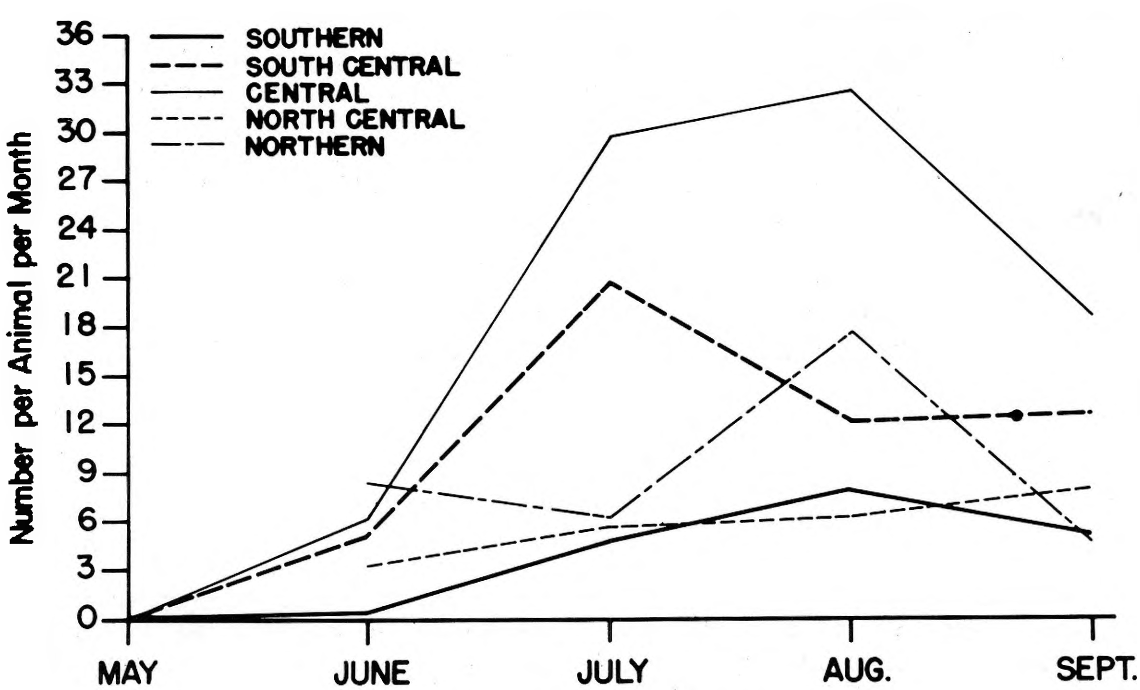

Figure 2. Horn fly populations, by areas, Illinois, 1968.

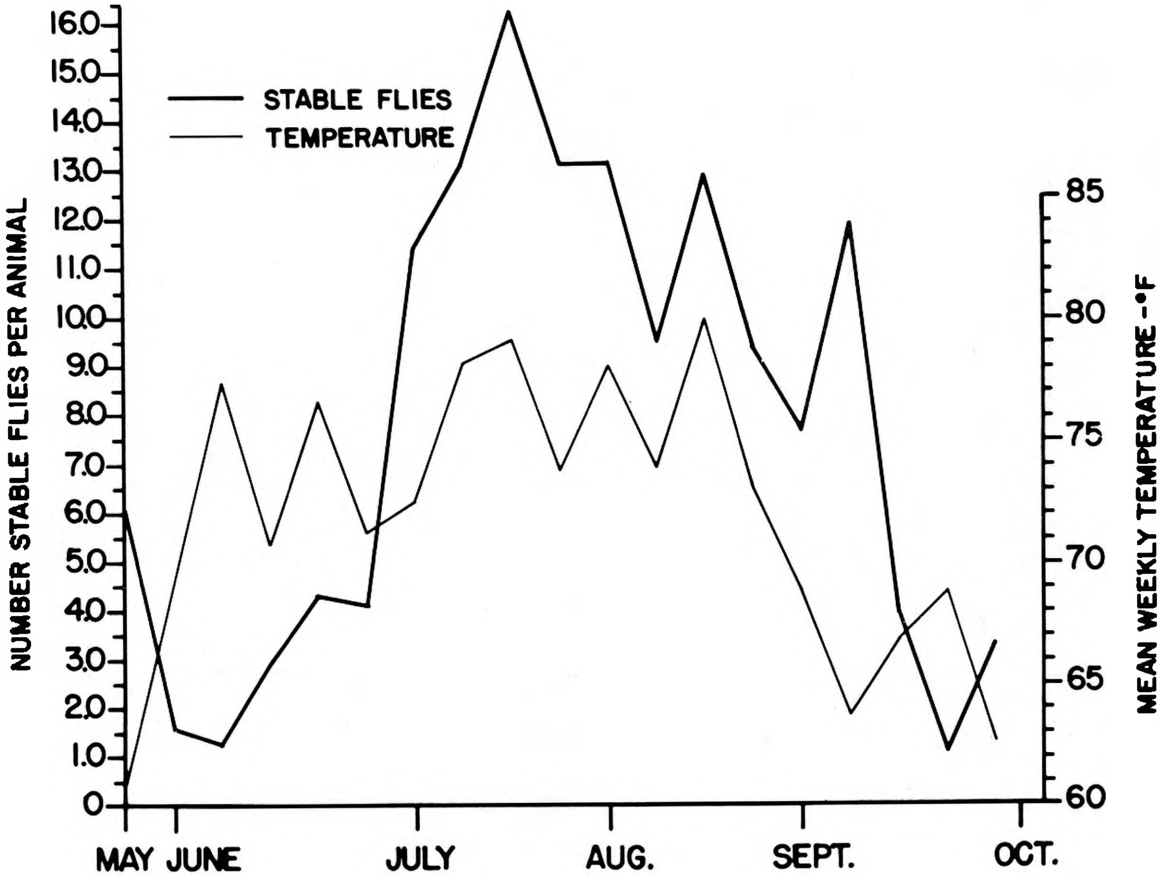

Figure 3. Stable fly populations, Illinois, 1968.

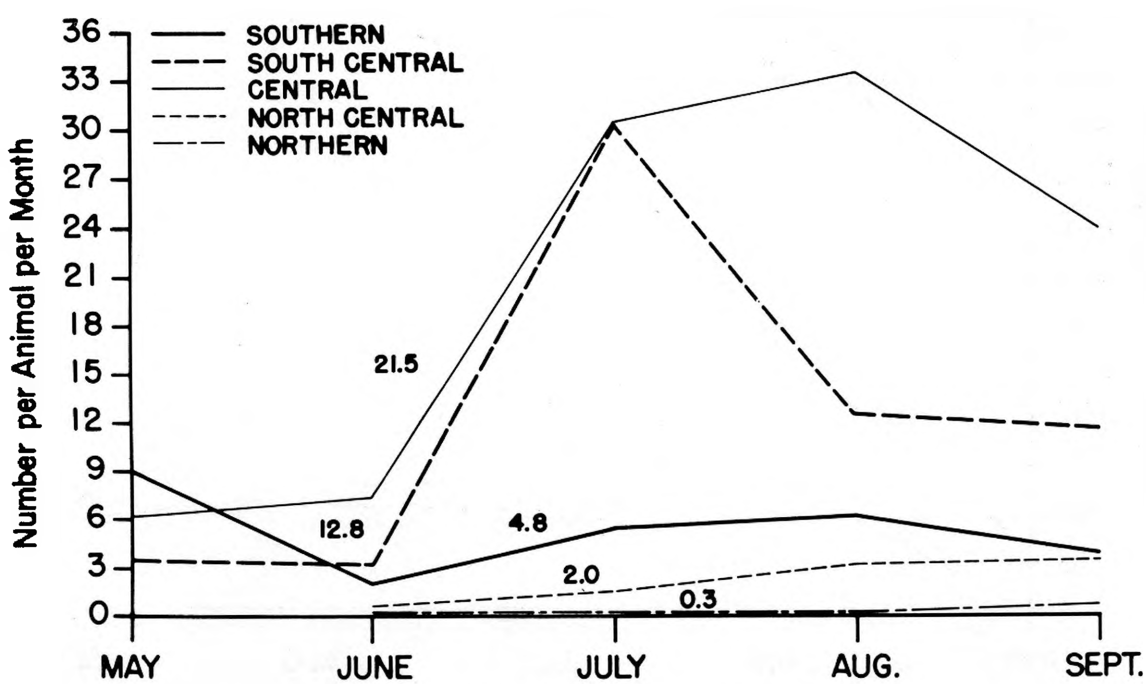

Figure 4. Stable fly populations, by areas, Illinois, 1968.

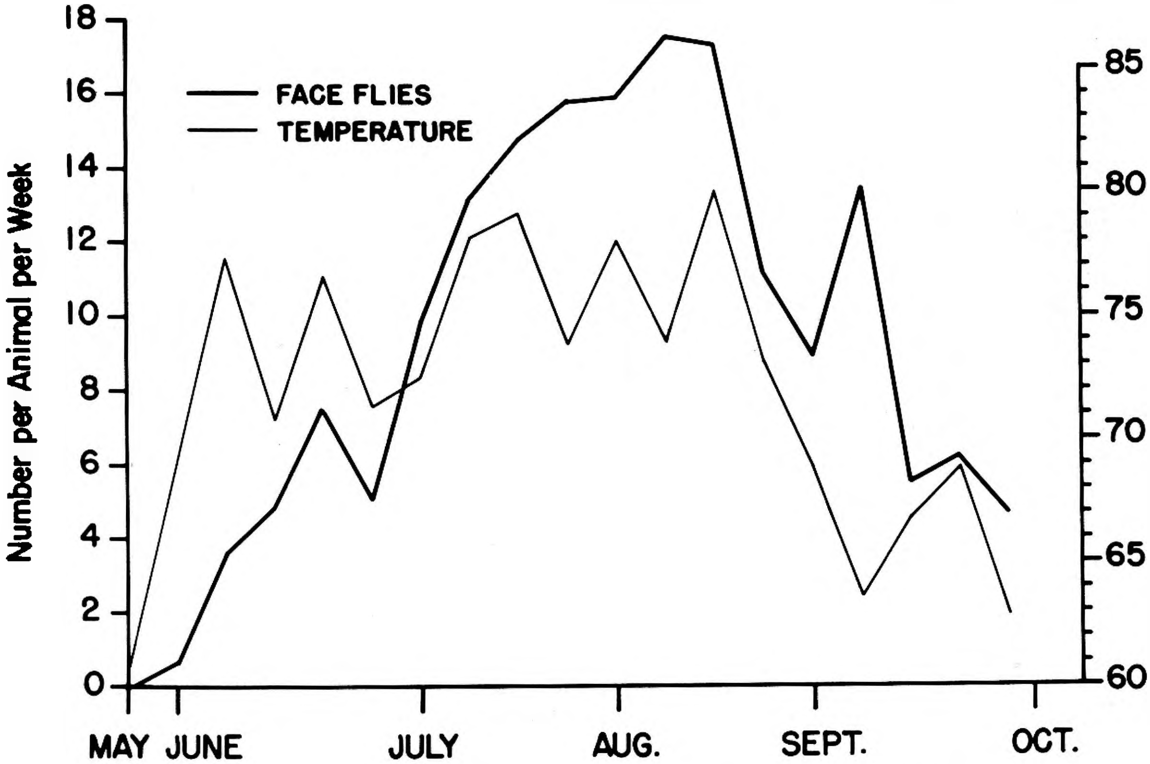

Figure 5. Face fly populations, Illinois, 1968.

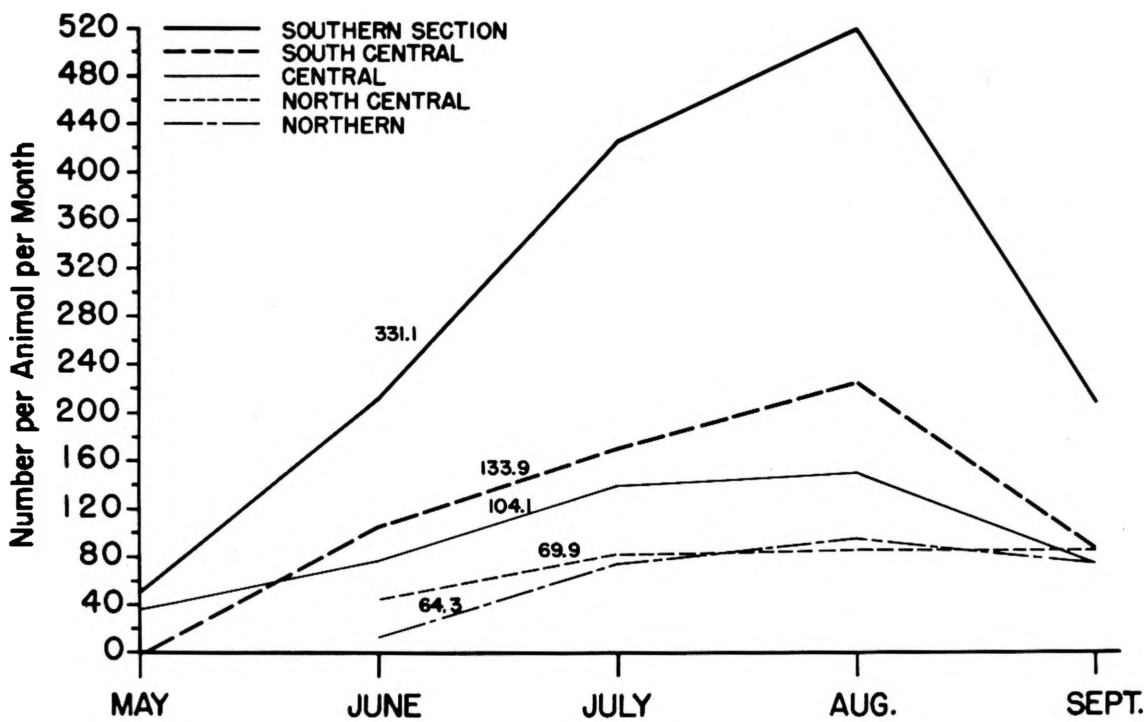

Figure 6. Face fly populations, by area, Illinois, 1968.

INSECT SITUATION, 1968

DONALD KUHLMAN, STEPHEN STURGEON, AND ROSCOE RANDELL

HIGHLIGHTS

The insect problems on field crops during 1968 were many and varied. The season started off in April with the alfalfa weevil, but damage was light in many fields because of parasitized larvae and rapid alfalfa growth. Seed-corn beetles and seed-corn maggots damaged corn in late May and early June. Corn rootworms and corn leaf aphids were in the spotlight during late June, July, and early August. The season ended with green cloverworms damaging soybeans and with high, second-generation European corn borer populations during late July and August.

The use of insecticides on field crops continued its general, upward trend during 1968. An estimated 7,115,207 acres of field crops were treated in 1968, with a saving to farmers of $34,434,233 over and above treatment costs (Table 1). The estimated total acreage treated was 4 percent greater in 1968 than in 1967. Insecticides for corn soil-insect control accounted for over 89 percent of the total acres treated in 1968.

In total, 6,261,869 acres (a 1 percent increase over 1967) of corn land were treated to protect against soil insects, while 853,338 acres (a 43 percent increase over 1967) were treated for all other insect pests of field crops. Of this total acreage, 7.1 percent was treated by commercial airplane applicators, 13.4 percent by commercial ground applicators, and 79.5 percent by individual farmers (Table 2). The acres treated for some of the major field crop insects by commercial and individual interests are given in Table 3.

As in past years, the county Extension advisers in agriculture answered a questionnaire concerning the use and application methods of insecticides in their county. This information is summarized in Tables 1 through 5. Each Extension adviser received an average of 550 inquiries concerning insects, of which 392 pertained to agricultural insects and 158 to home and garden insects. Extension advisers listed the following insects as those about which they received the most inquiries (in order, by decreasing interest):

1. Corn rootworms
2. European corn borer
3. Corn leaf aphid
4. Alfalfa weevil
5. Green cloverworm
6. Flea beetle
7. Black cutworms
8. Termites
9. Sod webworm
10. True armyworm
11. Seed-corn beetle
12. Grasshoppers
13. Garden insects
14. Tree insects
15. Bagworms
16. House flies
17. Spiders
18. Leafhoppers
19. Clover leaf weevil
20. Roaches

CORN INSECTS

Corn soil insects. They accounted for the major use of insecticides in 1968. Approximately 60 percent of the total corn acreage was treated, with a savings to farmers of $31,309,345 over and above treatment costs.

Table 1. Acres of Field Crops Treated with Insecticides and Estimated Profit from Treatments, Illinois, 1968

Crop and insect	Acres treated	Estimated profit[1/]
CORN		
Armyworms	3,401	$ 5,102
Corn flea beetle	41,880	209,400
Corn rootworm adults	30,502	122,008
Corn leaf aphid	368,355	1,841,775
Cutworms	33,916	203,496
European corn borer	126,279	315,698
Grasshoppers	3,683	3,683
Soil insects	6,261,869	31,309,345
TOTAL	6,869,885	$34,010,507
SOYBEANS		
Green cloverworm	92,131	27,639
Grasshopper	5,560	16,680
TOTAL	97,691	44,319
WHEAT		
Armyworms	32,844	131,376
CLOVER AND ALFALFA		
Alfalfa webworm	1,471	8,826
Alfalfa weevil	64,771	129,542
Clover leaf weevil	671	1,007
Grasshoppers	17,663	26,495
Meadow spittlebug	374	561
Pea aphid	1,573	3,146
Potato leafhopper	2,669	5,338
Variegated cutworm	3,669	7,338
TOTAL	92,861	182,253
FENCE ROWS, DITCH BANKS, ROAD SIDES, ETC.		
Grasshoppers	21,926	65,778
1968 total	7,115,207	34,434,233
1967 total	6,730,845	33,026,152

1/ Over and above treatment costs.

Table 2. Percent of Total Field Crops Treated by Commercial and Private Applicators in Illinois, 1958 Through 1968

Year	Percent of total acreage treated		
	Airplane application	Ground application	
		Commercial	Individual
1958	3.0	19.5	77.5[1/]
1959	2.6	14.5	82.9
1960	5.6	11.9	82.5
1961	7.4	12.0	80.6
1962	9.9	12.3	77.8
1963	9.2	18.8	72.0
1964	10.1	8.4	81.5
1965	4.9	10.4	84.3
1966	5.8	13.8	80.4
1967	5.5	14.7	79.8
1968	7.1	13.4	79.5

1/ First year in which soil insecticides were included in these calculations.

Table 3. Number of Acres Treated, by Method, for Certain Insects in Illinois, 1968

Insect	Acres treated		
	Airplane application	Ground application	
		Commercial	Individual
Clover & alfalfa treatment	25,166	15,499	38,079
Corn soil treatment	53,404	768,627	5,439,838
European corn borer	17,869	73,250	35,160
True armyworm	25,139	5,359	5,747
Soybean insects	64,173	14,252	11,480
Corn leaf aphids	290,775	52,300	25,280
TOTAL	476,526	929,287	5,555,584

Resistant western and northern corn rootworms increased and spread, with the result that farmers shifted from chlorinated hydrocarbon corn soil insecticides to the organic phosphates and carbamates. In 1968, chlorinated hydrocarbon insecticides (aldrin and heptachlor) were used on an estimated 5,170,726 acres; organic phosphates and carbamates, on 1,091,143 acres (Table 5). Granules were the preferred form of soil insecticide, accounting for 65 percent of the total used (Table 4). Some 13 percent was incorporated with fertilizer, and 22 percent was applied as a spray.

European corn borer. Populations increased sharply in 1968 throughout the state (Table 8).

First-generation populations were low, but the second-generation was the highest since 1955 (Tables 6 and 7). Last spring, large acreages of early planted corn provided corn borer moths with numerous egg-laying sites. Consequently, first-generation borer popualtions were low, although generally present in all fields.

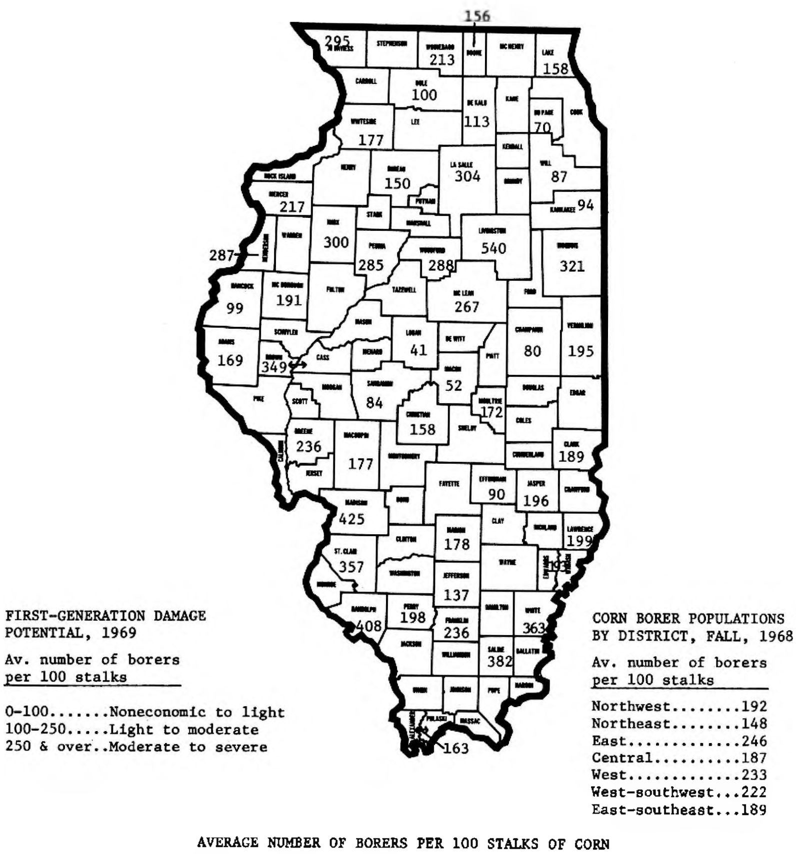

Figure 1. European corn borer prospects, 1968.

Second-generation, overwintering borer populations are high in all areas except for the central and northeastern sections (Figure 1). Where populations are high, there could be economic losses to early planted corn in 1969. The general incidence of borer parasites and diseases is low. Early planted fields in the problem areas should be watched closely during the spring of 1969 for borer feeding, initiating treatment if necessary.

Black cutworm. Damage was light in Illinois for the second consecutive year. An estimated 33,916 acres of corn were replanted because of cutworm injury. Damage was primarily confined to untreated or row-treated (aldrin and heptachlor) fields.

However, black cutworms cannot be discounted as a potential problem for 1969. Black cutworm moths migrate into Illinois in the spring and are usually a problem somewhere. It is impossible to forecast their severity in advance of the growing season. The trend toward planting corn earlier may increase cutworm damage wherever it does occur. The more mature the corn is when cutworms strike, the lower the chance of crop recovery and the more serious the loss in stand.

Corn leaf aphids. Infestations were severe in 1968, in sharp contrast to those of 1967. Most of the damage in 1968 occurred in the central and northeastern sections of Illinois. From July 18 to August 5, the fields that suffered the most damage were in the late-whorl to early tassel stage. Weather conditions favorable to aphid survival and reproduction and a lack of predators contributed to the rapid increase of aphid populations in these fields. An estimated 368,355 acres were treated.

Northern corn wootworms. Populations continued to increase throughout the northern half of Illinois in 1968. Pollination damage by adults was light, since most corn had pollinated before the peak, adult emergence during late July and early August. There were fewer reports of larval damage this year. This is attributed to (1) increased acreages of organo-phosphate and carbamate insecticides; (2) early planted corn, which enabled corn root systems to develop more fully before peak larval populations hit; and (3) less lodging because the excellent growing conditions permitted damaged roots to make a better recovery.

Table 4. Percent of Acreage Treated With Soil Insecticides Applied in Various Forms, 1958 Through 1968

Year	In fertilizer	As spray	As granules
1958	52	28	20
1959	44	26	30
1960	29	23	48
1961	35	21	44
1962	26	22	52
1963	22	23	55
1964	20	15	65
1965	14	15	71
1966	14	12	74
1967	13	22	65
1968	13	22	65

Table 5. Number of Corn Acres Treated With Different Types of Soil Insecticides, 1963 Through 1968

Year	Chlorinated hydrocarbons	Organic phosphates and carbamates
1963	4,049,318	...
1964	4,009,303	81,822
1965	4,544,432	189,352
1966	5,116,605	326,592
1967	5,601,572	602,721
1968	5,170,726	1,091,143

The main damage from northern corn rootworms was in fields of continuous corn, although there were a few reports of damage to first-year corn following alfalfa. An estimated 1,091,143 acres were treated with phosphates and carbamates for larval control, while an estimated 30,502 acres were treated for adult rootworm control. We consider all northern corn rootworms in Illinois resistant to the chlorinated hydrocarbons.

Seed-corn beetles. Problems increased dramatically in 1968. This pest eats the seed and chews off the sprout during germination, thereby reducing plant stands by a few hundred to several thousand plants per acre.

Soil treatments of aldrin and heptachlor and seed treatments of lindane, dieldrin, heptachlor, and aldrin failed to provide satisfactory control in many fields. The seed-corn beetle and seed-corn maggot seem to be resistant to the chlorinated hydrocarbon insecticides in these problem fields. An estimated 32,731 acres were replanted because of seed-corn beetle damage, and another 525,000 acres suffered slight damage.

Western corn rootworms. This pest was found in 17 additional counties in 1968, increasing to 37 the number of counties where the beetle is now present (Figure 2).

Table 6. *First- and Second-Generation Corn Borer Populations*[1/]

	July 1963	Oct. 1963	July 1964	Oct. 1964	July 1965	Oct. 1965	July 1966	Oct. 1966	July 1967	Oct. 1967	July 1968	Oct. 1968
Northwest												
*Ogle	21	121	11	96	0	18	3	58	13	52	0	100
*Whiteside	12	178	6	306	1	69	5	167	22	26	3	177
Bureau	24	370	5	179	3	74	9	129	17	113	1	150
*Mercer	47	287	28	275	9	49	30	109	16	76	3	217
Average	26	239	12	214	3	53	12	116	17	67	2	161
Northeast												
*Boone	1	88	9	34	3	11	6	66	16	12	0	156
*DeKalb	7	160	0	132	0	31	1	21	1	13	1	113
LaSalle	7	258	7	190	0	46	2	88	4	87	5	304
Average	5	169	5	119	1	29	3	58	7	37	2	191
East												
*Kankakee	5	52	4	79	1	28	0	56	1	41	1	94
*Iroquois	6	85	2	191	2	61	0	42	2	21	1	321
Livingston	2	83	10	163	1	32	0	84	13	65	5	540
*Champaign	0	14	1	9	0	10	0	8	0	7	0	80
Average	3	59	4	109	1	33	0	48	4	34	2	259
Central												
*McLean	3	65	3	43	0	45	6	103	4	82	0	267
Logan	1	47	1	17	0	10	3	28	1	30	0	41
Average	2	56	2	30	0	28	5	66	3	56	0	154
West												
*Knox	20	193	8	56	3	45	4	232	14	136	11	158
*McDonough	29	144	4	123	11	98	2	153	9	93	7	191
Average	25	169	6	90	7	72	3	193	12	115	9	246
West-Southwest												
Christian	0	15	1	15	0	23	1	15	2	74	0	158
Sangamon	0	10	2	12	0	8	0	15	0	16	0	84
Macoupin	1	24	1	120	2	73	9	84	2	53	3	177
Greene	0	18	1	78	4	81	11	167	14	147	7	236
Average	0.3	17	1	57	2	46	5	70	5	73	3	164
Overall average	10	116	5	111	2	43	5	86	8	60	3	195

1/ Asterisks indicate 11-county comparison (see Table 7).

Table 7. Average First- and Second-Generation Corn Borer Populations (11-County Comparison)1/

Year	First generation	Second generation
1958	16	103
1959	5	109
1960	9	117
1961	3	82
1962	10	139
1963	14	126
1964	7	122
1965	3	42
1966	5	92
1967	9	51
1968	3	183

1/ Starred counties, Table 6.

In 1969, they may spread to all counties north of a line from St. Louis to Danville. Severe damage could occur in many fields of second-year corn in the area north and west of a line from Dixon to Peoria to Stronghurst (Figure 2). Occasional fields of second-year corn in the outlying counties may also be damaged. Although second-year corn is more likely to be damaged than third-, fourth-, and fifth-year corn, etc., control measures should not be ignored for the latter.

All western corn rootworms in Illinois are resistant to the chlorinated hydrocarbons.

Corn flea beetles. These were numerous in many cornfields during the spring of 1968. An estimated 41,880 acres of corn were treated.

Common stalk borers. These were present in the border rows of many cornfields, causing a ragged appearance. By the time their presence was discovered, it was usually too late for treatment even if it would have been profitable. Keeping weeds cut during August along the edges of the fields will help prevent the problem during the following year.

Southwestern corn borers. These were found for the first time this year in Saline and Gallatin counties, and has now been identified in 9 of the southernmost counties (Figure 3). In Pulaski and Alexander counties, 80 percent of the fields surveyed were infested. The average for 10 fields was 21.6 percent of the stalks infested and 4.5 percent of the stalks broken off.

In 1969, we expect moderate to severe damage to late-planted corn in Pulaski, Alexander, Massac, Union, Johnson, Pope, and Hardin counties. The remainder of the infested area will have light to noneconomic damage to late corn.

Potentially, the southwestern corn borer is a more serious pest than the European corn borer. Fortunately, movement northward in Illinois is limited by its inability to overwinter successfully. However, it appears to be slowly adapting to midwestern conditions.

SMALL GRAINS

True armyworms. Populations were much lower in wheat fields during May and June than in 1967. An estimated 32,844 acres were treated for control in 1968, compared to 89,134 acres in 1967. The armyworm, which is a southern migrant, usually presents some problem every year. It is impossible to predict the area or severity of infestation more than a few weeks in advance.

Cereal leaf beetles. These continue to spread in Illinois. A few specimens were found for the first time this summer in Shelby, Moultrie, Champaign, Livingston, Grundy, and Cook counties (Figure 5).

Last spring, an aerial spray program was completed on an area a mile or more in radius at sites where cereal leaf beetles were collected in 1967. A total of 413,600 acres were treated with technical-grade malathion (9.7 pounds per gallon), at the rate of 4 fluid ounces per acre in Champaign, Douglas, Edgar, Iroquois, Kankakee, Vermilion, Will, and Woodford counties. Small portions of Champaign and Douglas counties were treated because they were near a 1967 find in neighboring counties. This work was done by federal and state regulatory personnel under the supervision of T.J. Lanier, Supervisor, Plant Pest Control, Agricultural Research Service, USDA, and W.T. Larkin of the Illinois Department of Agriculture.

In the spring of 1969, sites of new finds in Shelby, Moultrie, Champaign, Livingston, and Grundy counties may be treated. Crop damage from the cereal leaf beetle is not expected in Illinois during 1969. Parts or all of the infested counties have been placed under a federal quarantine. Surveys will be conducted by regulatory officials in 1969 to detect the spread of this insect.

Hessian flies. Populations declined for the second straight year, after reaching a high of 14.4 flaxseeds per 1,000 tillers in 1966. The 1965 and 1968 populations were the lowest of the past 13 years. The state average for 1968 is 2 puparia per 100 tillers (Table 9). The average number of puparia per 100 tillers is given for counties surveyed in August (Figure 6).

Even when fly populations are low, it is advisable to observe the date for optimum yield or to use a resistant variety.

CLOVER AND ALFALFA INSECTS

Alfalfa weevils. These are now present in every county in Illinois, having been found for the first time in 1968 in Jo Daviess, Stephenson, Winnebago, and Ogle counties.

In 1969, we can expect moderate-to-severe damage in the area south of a line from Watseka to Hardin; light to moderate damage, in the area south of a line from Aurora to Carthage and north of a line from Watseka to Hardin; and noneconomic, light damage, in the area north of a line from Aurora to Carthage (Figure 7).

The buildup of alfalfa weevils and damage from them were delayed about 2 weeks this spring by cool weather, while alfalfa growth was about 2 weeks ahead. Wasp parasites also helped check alfalfa weevil populations.

Meadow spittlebugs. These bugs were more numerous last spring in all sections of the state. Froth masses were easily found in clover and alfalfa fields, but damage by the nymphs was light to noneconomic. Treatment was seldom justified.

Our fall adult survey (Figure 8) indicates that populations increased slightly in all areas except in northwestern Illinois. However, damage in 1969 will be noneconomic.

Table 8. Corn Borer Fall Population Surveys in 36 Counties, 1957 Through 1967 (County Averages Expressed in Borers Per 100 Stalks of Corn)

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
Northwest											
Jo Daviess	94	114	68	46	98	70	146	17	69	39	295
Winnebago	57	83	131	51	114	214	93	28	54	34	213
Ogle	124	211	125	49	95	121	96	18	58	52	100
Whiteside	165	184	76	131	29	178	306	69	167	26	177
Bureau	158	208	36	97	135	370	179	74	129	113	150
Mercer	164	100	132	111	428	287	275	49	109	76	217
Average	126	150	95	81	150	207	183	43	98	57	192
Northeast											
Boone	36	64	75	47	70	88	34	11	66	12	156
Lake	57	39	24	12	13	15	59	10	33	11	158
DeKalb	99	200	57	126	81	160	132	31	21	13	113
DuPage	55	59	65	34	53	58	45	11	33	30	70
Will	36	75	92	76	101	119	78	16	38	37	87
LaSalle	101	120	55	127	66	258	163	46	88	87	304
Average	64	93	61	70	64	116	90	21	47	32	148
East											
Kankakee	48	107	59	133	152	52	79	28	56	41	94
Iroquois	47	61	122	109	198	85	191	61	42	21	321
Livingston	93	85	129	59	81	83	163	32	84	65	540
Vermilion	34	11	41	14	42	14	11	17	16	11	195
Champaign	24	3	13	5	10	14	9	10	8	7	80
Average	49	53	73	64	97	50	91	30	41	29	246
Central											
Peoria	81	53	160	121	237	110	106	66	708	191	285
Woodford	168	121	205	122	131	210	154	81	493	125	288
McLean	134	118	247	49	88	65	43	45	103	82	267
Logan	98	12	54	18	23	47	30	10	28	30	41
Macon	31	28	29	12	23	14	17	6	5	23	52
Average	102	66	139	64	100	89	70	42	267	90	187
West											
Henderson	146	87	136	117	174	150	223	106	285	115	287
Knox	203	108	135	53	190	194	56	45	232	136	300
Hancock	192	64	278	35	142	206	102	89	171	109	99
McDonough	149	65	193	48	192	144	123	98	153	93	191
Adams	138	175	207	62	129	118	179	73	502	98	169
Brown-Cass	98	109	91	41	67	88	117	84	148	58	349
Average	154	101	173	59	149	150	133	83	249	102	233
West-Southwest											
Sangamon	35	14	90	13	20	10	12	8	15	16	84
Christian	73	36	114	21	24	15	15	23	15	74	158
Madison	29	33	111	77	150	56	30	126	90	107	425
Average	46	28	105	37	65	27	19	52	40	66	222
Southwest											
St. Clair	9	9	38	13	89	108	46	98	96	110	357
Average	9	9	38	13	89	108	46	98	96	110	357
East-Southeast											
Moultrie	53	9	29	6	30	23	4	13	22	66	172
Clark	16	27	20	12	20	21	16	151	74	8	189
Jasper	18	16	49	53	102	25	24	40	44	59	196
Lawrence	31	29	41	8	44	22	28	62	48	15	199
Average	20	20	35	20	49	23	18	67	47	37	189
AVERAGE, ABOVE 36 COUNTIES. . .	86	79	98	59	101	106	95	49	120	61	205
AVERAGE, ALL COUNTIES SURVEYED.	73	74	101	56	99	98	100	57	112	57	211

Table 9. Hessian Fly Populations, by Sections, July 1958 Through 1968

Section	Flaxseeds per 100 tillers										
	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
West	1.6	8.0	4.4	1.5	10.8	7.5	2.2	2.0	7.2	2.5	1.0
Central	0.8	20.8	4.7	2.0	3.3	4.0	1.6	0.0	2.1	1.0	0.0
East	1.6	0.8	6.9	1.5	5.2	3.0	0.0	2.0	0.0	0.5	0.0
West-southwest	3.4	16.4	18.0	21.2	24.1	10.5	1.9	1.1	15.9	3.7	0.18
East-southeast	6.2	10.0	10.0	3.8	12.4	2.5	4.2	0.4	25.6	4.2	4.3
Southwest	2.9	5.4	10.7	7.7	11.9	1.2	10.1	3.7	8.8	2.8	4.2
Southeast	0.2	6.2	15.7	3.6	10.9	3.0	1.0	0.8	22.6	13.0	2.0
State average	2.9	9.2	11.4	8.0	11.2	4.8	3.4	1.5	14.4	5.3	1.9

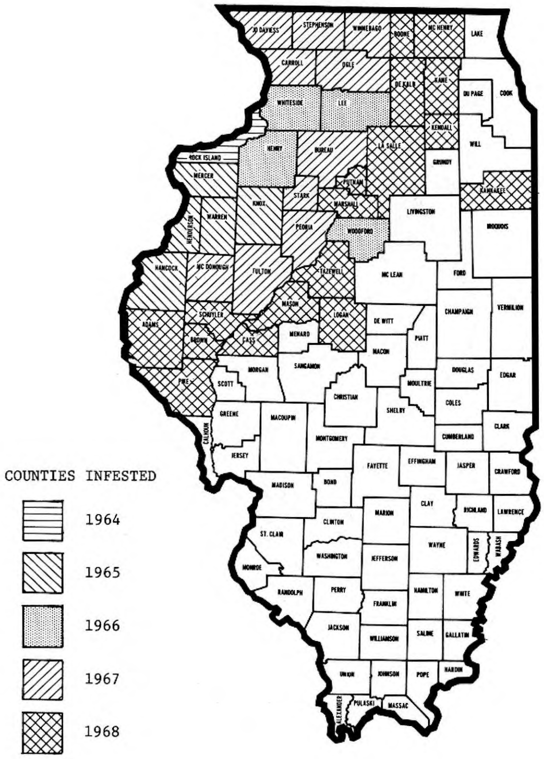

Figure 2. Western corn rootworm prospects, 1969.

Figure 3. Southwestern corn borer prospects, 1969.

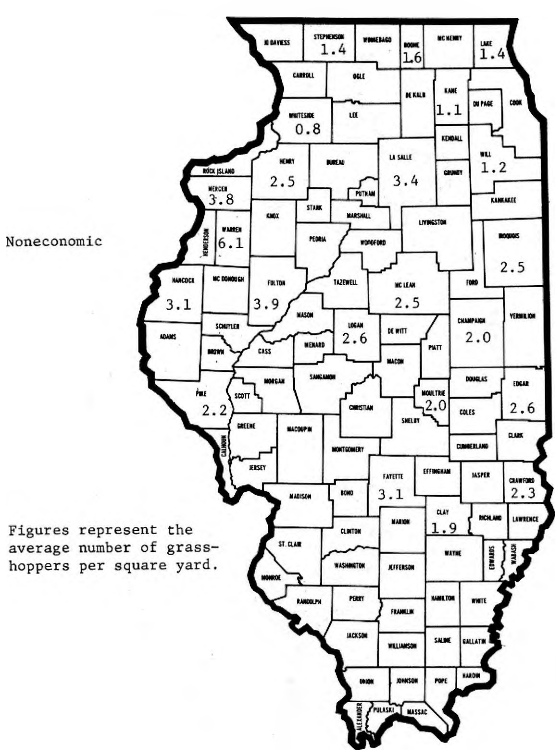

Figure 4. Grasshopper prospects, 1969.

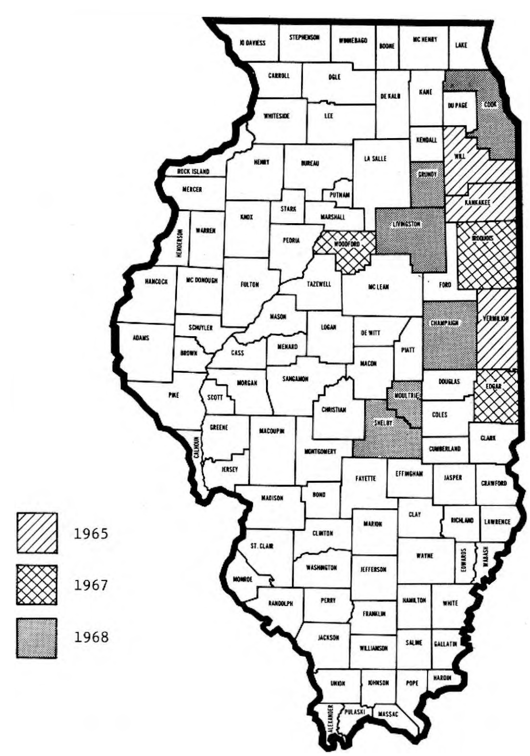

Figure 5. Cereal leaf beetle distribution, 1968.

Figure 6. Hessian fly populations, summer, 1968.

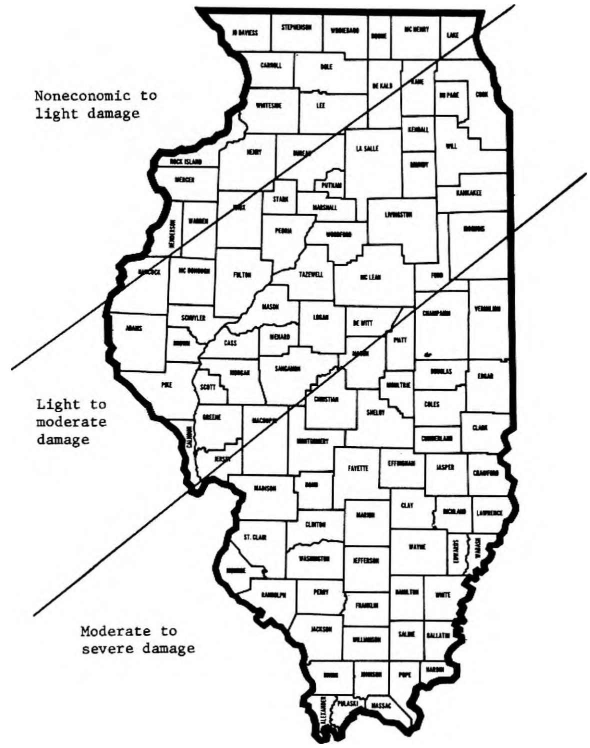

Figure 7. Alfalfa weevil prospects, 1969.

SOYBEAN INSECTS

Green cloverworms. Populations reached damaging numbers in late July and early August in many soybean fields in central Illinois. An estimated 92,131 acres were treated for control. A fungus disease hit when populations reached their peak and provided effective control.

Thistle caterpillars (larvae of painted lady butterflies). This pest damaged soybeans in mid-June in some areas of northeastern Illinois, migrating to bean fields after feeding on thistles and related plants. In general, infestations were not serious.

GENERAL INSECTS

Grasshoppers. Populations have increased slightly over most of the state, but are still considered noneconomic (Figure 4). However, spotted heavy infestations may occur in 1969 if the weather is hot and dry during egg-hatch time in June.

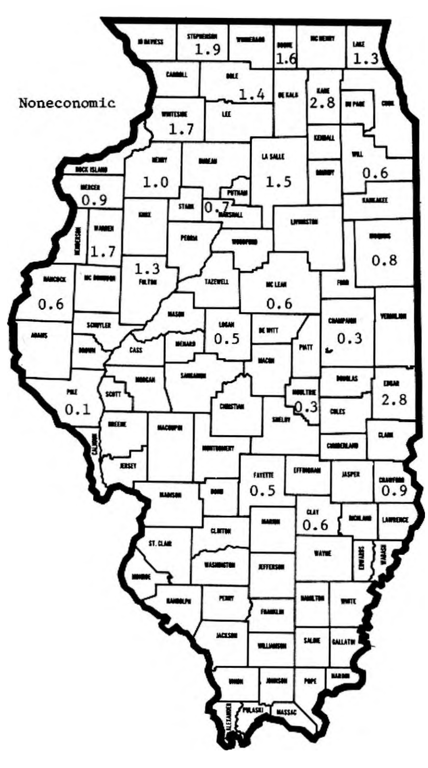

Figure 8. Meadow spittlebug prospects, 1969.

NORTHERN CORN LEAF BLIGHT CONTROL WITH A FUNGICIDE

M.P. BRITTON

Information gathered from aerial and ground application of Dithane M-45[1/] during 1968 indicates that the control of Northern Corn Leaf Blight with fungicides may be feasible in dent corn.

PROGRESSION OF THE DISEASE

As the season progressed, the disease spread from the early infected plants to those surrounding them--forming "centers" of infection, with the plants in the center being those having the greatest damage and progressively less damage to plants further from the center. Yield reduction was greater on the severely damaged plants. At Ipava, Illinois, approximately 25 percent of the plants were rated from 2.5 to 3.5, and the bulk of the yield reduction in unsprayed plots probably occurred on them.

INCREASED DIFFERENCES

Yield increases were obtained with two applications of 2 pounds of total fungicide per acre, applied at early-silking and late-silking, respectively. Disease development occurred early in the year at Ipava, Illinois. The 17.6-percent increase in yield there is highly encouraging (Table 2). The 7- to 8-percent increases in yield at Grand Ridge and Tonica were unexpected because the average level of infection per acre was quite low in these fields throughout the entire season.

A possible explanation for the increases can be drawn from an examination of the data presented in Figure 1. It is readily apparent that plants varied in the degree to which they were damaged by Northern Corn Leaf Blight. Undoubtedly, those plants with severe damage (3.5, 3.0, and 2.5) had been infected earlier than the other plants.

Table 1. The Effect of Dithane M-45 on Corn Yields at Four Locations in Illinois, 1968

Location	Bushels per acre, No. 2 corn		Percent
	Untreated	Dithane M-45	increase
Grand Ridge	73.9	79.8	8.0
Tonica	65.2	69.9	7.2
Geneseo	78.7	77.6	...
Ipava	65.5	77.0	17.6

1/ A coordination product of zinc ion and manganese ethylene bis dithiocarbamate.

Table 2. Northern Corn Leaf Blight Intensity

Location	Lesions per acre (intensity rating)		
	Silking	Milk	Dough
Grand Ridge	550	3,850	16,400
Tonica	2,750	22,650	88,650
Geneseo	2,850	14,825	35,450
Ipava	24,100	1.3[a]	2.3[b]

a/ Several lesions on lower leaves of plants.
b/ Many lesions on lower leaves, several on middle leaves of plants.

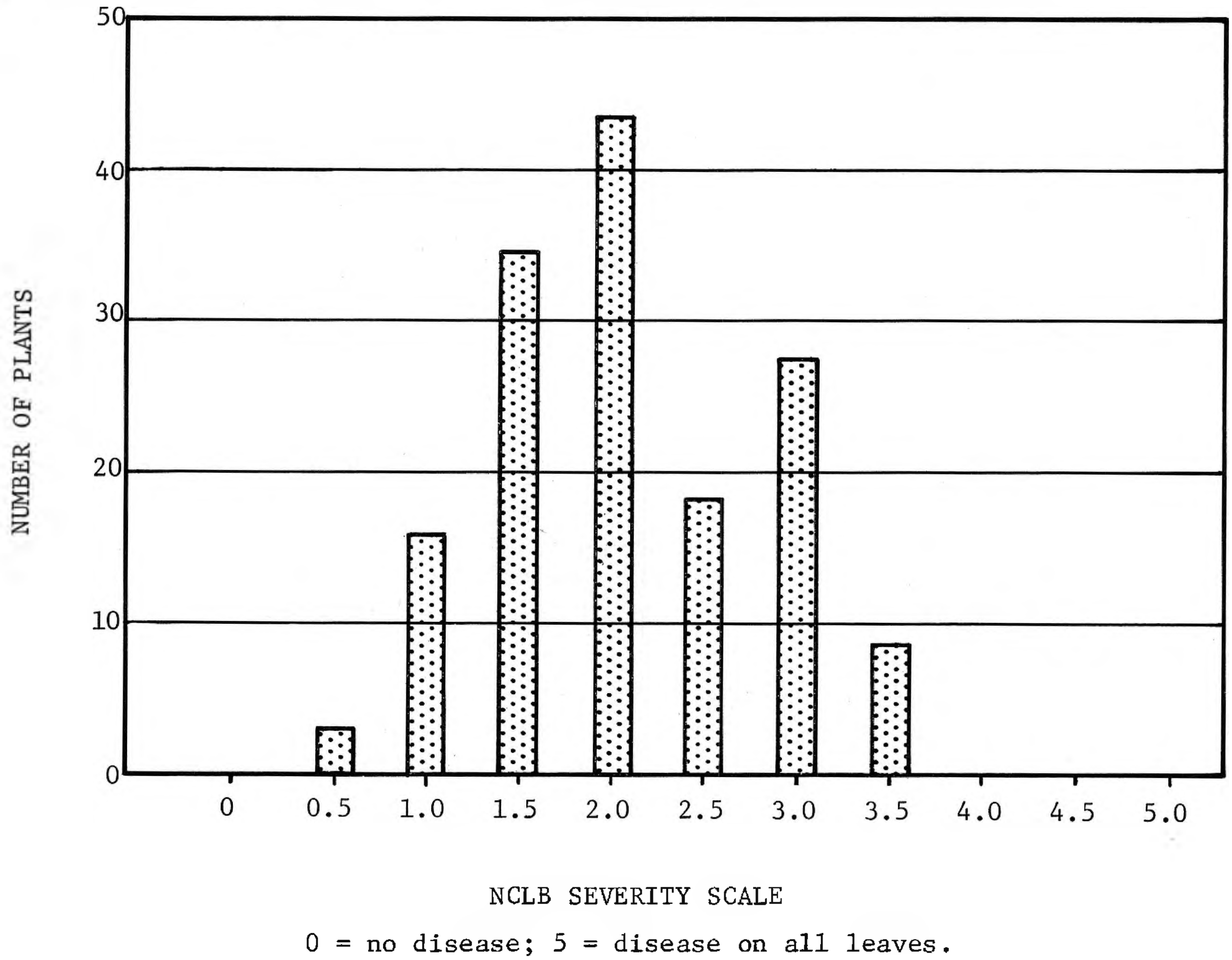

Figure 1. The average number of corn plants at each level of leaf damage caused by NCLB in 1/100th-acre plots, Ipava, Illinois, September 5, 1968.

A similar situation occurred at the other locations. In these fields, however, the infection centers were smaller and the number of severely diseased plants was smaller. Therefore, the benefits from spraying were correspondingly less.

The lack of yield difference at Geneseo probably occurred because on both dates when aerial application was being made, strong winds caused the fungicide to drift onto the control plots.

MAJOR CHANGES IN 1969 INSECTICIDE SUGGESTIONS

H.B. PETTY

FIELD-CROP PESTS

1. We continue to urge *dairy farmers* to avoid using several chlorinated hydrocarbons on their dairy farms. These are aldrin, chlordane, dieldrin, DDT, endrin, heptachlor, and lindane.

2. We urge *soybean growers* not to use aldrin, chlordane, dieldrin, endrin, heptachlor, or lindane as soil or foliar treatments for beans. We urge bean growers to allow two years between a crop of beans and the last application of aldrin or heptachlor, after they have been used for five consecutive years.

3. *Second-year corn* may be damaged by western corn rootworms in the area west and north of a line from Stronghurst to Peoria (Highway 116) and north through Dixon to the Wisconsin border. These beetles are all resistant to aldrin and heptachlor.

4. Northern corn rootworms are regarded as *resistant* to aldrin and heptachlor throughout Illinois.

5. Seed-corn beetles and seed-corn maggots are now *resistant* to aldrin and heptachlor.

6. We have replaced dieldrin, heptachlor, or lindane corn seed treatment with *diazinon*.

7. If you are using aldrin or heptachlor as a soil treatment in fields where rootworms are not a problem, use diazinon as a *seed treatment*.

8. On *dairy farms*, use diazinon or one of the other phosphates as a planter treatment for control of the general soil-insect complex. If *garden symphylans* are thought to be a problem, use *dyfonate*.

9. For corn rootworms, use Furadan (if labeled), BUXten, dasanit, dyfonate, or phorate as *planting-time treatments*, at 1 pound per acre for rootworm control. To protect against seed-insect attack, use diazinon as a seed treatment if you use BUXten at planting.

10. Concerning *basal applications* for corn rootworm in late May to mid-June, we have added *parathion* and *carbaryl* and retained diazinon, disulfoton, and phorate. If you use a basal treatment and no planting-time soil treatment, use a seed protectant such as diazinon.

11. Treatment to control corn leaf aphid is justified if 50 percent or more of the plants are lightly to moderately infested and the corn is in the late-whorl to early tassel stage of growth. This is particularly true if the corn is under stress. At the latest, treatments should be made prior to brown silks.

12. For green cloverworm on soybeans, we have dropped toxaphene and are adding *malathion* or carbaryl.

13. Use carbaryl on soybeans only at 1 pound per acre. Two pounds per acre may injure the crop.

14. Do not use methyl parathion at rates above the recommended ones for alfalfa weevil control; we have seen *foliage damage* by the chemical. Some leaf spotting or discoloration also occurred from other phosphates.

LIVESTOCK INSECTS

15. We have added Ciodrin for *face fly control* on pastured beef and dairy cattle and for *mange control* on dairy cattle.

16. Ruelene is included as a *drench* for *sheep nose bots*.

17. Toxaphene has been added for *mange* control on beef cattle and swine.

18. Rabon has been added as a *house fly residual* barn spray.

METABOLISM AND THE SELECTIVITY OF NEW INSECTICIDES

R.L. METCALF

The concept of selectivity is implicit in the application of insecticides, since the human user certainly does not expect to share equally with his intended arthropod victim in the hazards of unrestricted chemical warfare. Also, he does not expect that his normal use of plant sprays will harm foliage or fruits or that applications to livestock will be deleterious to their health. The major factor permitting the safe use of insecticides is their rapid metabolism in the bodies of warm-blooded animals, where the liver is the chief site of the biochemical processes (collectively termed detoxication) that convert foreign molecules (xenobiotics) into harmless, water-soluble fragments; these are rapidly eliminated from the body.

A knowledge of pesticide metabolism and detoxication is therefore of paramount importance in:

1. Developing new insecticides that are selectively toxic to insects and relatively nontoxic to mammals.

2. Demonstrating that residues of insecticides on raw agricultural commodities will be rapidly degraded to harmless metabolites and will not accumulate in the bodies of man and animals.

3. Providing for biodegradability in the environment so that normal insecticide usage will not contaminate soil, water, or air.

A thorough knowledge of these factors is required to license and register new pesticides with the U.S. Department of Agriculture and the U.S. Food and Drug Administration.

THE IMPORTANCE OF METABOLISM

The vital role played by inactivation or detoxication of a pesticide can be illustrated with a familiar example. Nicotine was once widely used as an insecticide; it is well known as a violent poison to higher animals, with an oral LD_{50} to the rat of about 55 milligrams per kilogram. A recent report of the U.S. Surgeon General (1965) has stated that about 5,360 metric tons of nicotine, as an ingredient in tobacco smoke, are fumed each year in cigarettes alone; also, that the average U.S. inhabitant of 15 years or over inhales between 6 and 8 grams of nicotine per year, a dosage for the smoker of at least 150 times the single, oral lethal dose for man. It is obvious that the Surgeon General's committee could not have concluded that "the chronic toxicity of nicotine...is very low and probably does not represent a significant health problem" if the human body did not possess an efficient mechanism for absorbing, distributing, metabolizing, and eliminating nicotine in the form of 10 or more degradation products.

Chlorinated hydrocarbon insecticides. In general, these are highly fat-soluble and are biochemically and environmentally stable. DDT, despite its enormous value in controlling insect pests affecting human and animal health and agriculture, is essentially nonbiodegradable. It has a half-life in the living animal body of about 2 years, compared with less than 2 days for a truly biodegradable compound such as the carbamate insecticide carbaryl. As a consequence of this very slow biological breakdown and the enormous quantities utilized since 1946 (about 3.5 billion pounds), DDT in trace amounts is virtually ubiquitous in the biosphere, appearing in human fat of U.S. inhabitants to an average value of about 3 to 7 parts per million and pervading much of our agricultural soils and water resources in parts-per-trillion to parts-per-million concentrations. Such trace concentrations, although they are apparently physiologically and biochemically innocuous, are clearly undesirable, and become of importance when they enter biological food chains and are concentrated through successive consumption by carnivors. The fish and birds at the end of these food chains may contain residues of DDT in their fatty tissues reaching 100 to 1,000 p.p.m., levels that have been shown to be deleterious to growth and reproduction.

Public concern about environmental contamination by DDT and other chlorinated hydrocarbons has demonstrated the wisdom of careful studies concerning pesticide metabolism in relation to the ultimate use of these pesticides. Clearly, it is important to implement the use of biodegradable insecticides wherever there is a possibility of significant environmental contamination. In this regard, methoxychlor (the close relative of DDT) has a similar spectrum of insecticidal activity. Yet because of its unique pathways of degradative metabolism, it is rapidly broken down and excited from living organisms, instead of being stored in the fat as is DDT.

A comparison of the two materials is given in Table 1. The utilization of methoxychlor instead of DDT should be given the highest priority. Experience suggests that if methoxychlor had originally been chosen in 1946 for widescale development instead of its cousin DDT, the pesticide controversy of today might never have arisen.

Table 1. Comparative Toxicology of DDT and Methoxychlor

	DDT	Methoxychlor
Rat--acute oral LD_{50}	250	6,000
Fat storage at:	10-20x intake	0.01-0.1x intake

Organophosphorous and carbamate insecticides. These are generally biodegradable and nonaccumulative in plant and animal tissues, in the soil, or through food chains in the environment. Basically this is because they are all esters that readily tend to hydrolyze through the action of water and of specific enzymes to form predominantly water-soluble moieties, which are essentially nontoxic and are rapidly eliminated from animal bodies. An indication of the difference in this behavior from the more-stable organochlorine compounds is shown in Table 2. The use of these biodegradable phosphates and carbamates is increasing in forest, rangeland, and aquatic areas, as well as in agricultural uses where the possibility exists of contaminating wildlife and the environment.

Table 2. Half-Life Values for Elimination or Decomposition of Insecticides in Animals and in Soil

Insecticide	Approximate time for one-half to disappear (T1/2) Living animal	Soil
DDT	6 months	8-20 months
aldrin	ca.1 year	2.4-3.75 months
carbaryl	1.5 days (dog)	8 days
malathion	<1 day	1 day
methyl parathion	12 hours	2 days

Metabolic pathways for the detoxication of the organophosphorous insecticides such as malathion and methyl parathion involve oxidative activation to their respective oxygen analogues malaoxon and methyl paraoxon, which are the active toxicants. However, in their activated form, these compounds are much less stable than the parent compounds, undergoing rapid hydrolytic destruction to a number of nontoxic, water-soluble products. Ultimately, these metabolic pathways (as shown in slides) lead to phosphoric acid and represent complete biodegradability.

The carbamate insecticides are detoxified by oxidative action that introduces hydroxyl groups into ring and *N*-methyl moieties. These groups lead to hydrolytic instability and to conjugation and elimination from the animal body. Examples are shown of the metabolic pathways for carbaryl, Furadan, and Temik (slides). In general, the metabolic products of these insecticides are much less toxic than the parent insecticides, as shown in Table 3.

Table 3. Toxicity of Metabolic Products of Carbamate and Phosphate Insecticides

	I_{50} fly ChE	LD_{50} housefly	LC_{50} *Culex* mosquito
	M	(μg./g.)	(p.p.m.)
methyl parathion	$>1.0 \times 10^{-3}$	1.2	0.018
methyl paraoxon	1.0×10^{-7}	2.5	0.02
desmethyl methyl parathion	$>1.0 \times 10^{-3}$	>500	>10
dimethyl phosphorothioic acid	$>1.0 \times 10^{-3}$	>500	>10
Furadan	2.5×10^{-7}	6.7	0.054
3-OH Furadan	1.4×10^{-6}	>500	0.75
3-C=O Furadan	1.3×10^{-5}	>500	1.7
N-CH_2OH Furadan	2.9×10^{-5}	>500	5.2
Furadan phenol	$>1.0 \times 10^{-3}$	>500	>10
Temik	8.4×10^{-5}	5.5	0.16
Temik sulfoxide	1.1×10^{-6}	2.4	0.168
Temik sulfone	5.0×10^{-6}	9.0	0.55
Temik oxime	$>1.0 \times 10^{-3}$	>500	>10

We are all anxious to use more-sophisticated insecticides that are highly toxic to insects and of low toxicity to mammals. The most-practical way to achieve this is to find molecular structures that are rapidly metabolized in the mammal but which the insect cannot readily degrade. Malathion is a good example of a highly selective insecticide that is very safe to mammals (rat oral LD_{50} 1,000 to 1,375 milligrams per kilogram). The carboxyesterase enzymes of the mammalian liver readily remove the terminal ethyl ester groups, forming inactive malathion acids. By contrast, there is little difference in the metabolism of methyl parathion in insects and mammals, and this compound (rat oral LD_{50} 14 to 20 milligrams per kilogram) is highly toxic to both.

The carbamate insecticide carbaryl or Sevin (rat oral LD_{50} 540 milligrams per kilogram) is also highly selective, and is rapidly destroyed in the mammalian liver. Its close relative Furadan (rat oral LD_{50} 8 milligrams per kilogram) is toxic to both mammals and insects and shows little difference in its pathways of metabolism.

Hydrolytic metabolism, the characteristic pathway for the organophosphorous and carbamate insecticides, destroys their toxicity to all animals and insects. These compounds are all synthetic analogs of the neurohormone acetyl choline, a substance produced in the bodies of all creatures with central nervous systems. Neurohormone acetyl choline is responsible for the transmission of nerve impulses between nerve cells. Transmission depends on the ability of the intact ester acetyl choline to depolarize the postsynaptic membrane and then to be hydrolyzed very rapidly by an enzyme cholinesterase, so as to remove the transmitter from the synaptic area. The action of cholinesterase (EH) can be depicted as:

1. $\underset{\text{acetyl choline}}{CH_3\overset{O}{\overset{\|}{C}}OCH_2CH_2\overset{+}{N}(CH_3)_3} + EH \underset{k-1}{\overset{ki}{\rightleftarrows}} CH_3\overset{O}{\overset{\|}{C}}OCH_2CH_2\overset{+}{N}(CH_3)_3\cdot EH$

2. $CH_3\overset{O}{\overset{\|}{C}}OCH_2CH_2\overset{+}{N}(CH_3)_3\cdot EH \xrightarrow{k_2} CH_3\overset{O}{\overset{\|}{C}}\cdot E + \underset{\text{choline}}{HOCH_2CH_2\overset{+}{N}(CH_3)_3}$

3. $CH_3\overset{O}{\overset{\|}{C}}\cdot E + H_2O \xrightarrow{k_3} EH + \underset{\text{acetic acid}}{CH_3\overset{O}{\overset{\|}{C}}OH}$

The organophosphorous ester analogues mimic the reaction of acetyl choline with cholinesterase:

1. $(RO)_2\overset{O}{\overset{\|}{P}}X + EH \underset{k-1}{\overset{ki}{\rightleftarrows}} (RO)_2\overset{O}{\overset{\|}{P}}X\cdot EH$

2. $(RO)_2\overset{O}{\overset{\|}{P}}X\cdot EH \xrightarrow{k2} (RO)_2\overset{O}{\overset{\|}{P}}\cdot E + HX$

3. $(RO)_2\overset{O}{\overset{\|}{P}}\cdot E + H_2O \xrightarrow{k3} EH + (RO)_2\overset{O}{\overset{\|}{P}}OH$

With acetyl choline, step 3 occurs very rapidly and step 1 determines the rate. With the organophosphorous ester insecticide, step 3 occurs very slowly over a matter of days, acting as the rate-determining one, and the phosphorylated enzyme is "poisoned" so that it cannot carry out its normal function of the hydrolysis of acetyl choline. The carbamate insecticides behave similarly to the organophosphorous insecticides, carbamylating the enzyme as in step 3 with consequent "poisoning." As the cholinesterase is thus phosphorylated or carbamylated, the characteristic symptoms of neurotoxicity appear: irritability, tremors, hyperactivity, convulsions, salivation, vomiting, etc. With both phosphate and carbamate, hydrolysis slowly occurs, and these compounds act as poor substrates for the cholinesterase enzyme.

CLOSING COMMENTS

This brief discussion about mode of action should make it clear that preliminary hydrolytic destruction of a phosphate or carbamate by aqueous systems elsewhere in the body will effectively prevent the insecticides from reacting with the cholinesterase at the target site in the nervous system. The compounds are thus detoxified.

The hope is that this discussion has clarified the essential position of metabolism or breakdown of insecticides in determining how they interact with vital biochemical systems to kill insects, how they act as selective insecticides, and how biodegradability in the environment can be achieved.

CORN LEAF APHID AND CORN YIELDS

ROSCOE RANDELL

Corn leaf aphid infestations were again severe in 1968 in the north-central sections of the state, on each side of a line from Quincy to Kankakee. Winged adults began migrating into the state during the week of July 8 to 15. As in 1966, these winged adults entered the whorls of corn plants and began giving birth to young. Soon, many fields of corn in this area of the state had 75 to 80 percent of the corn plants infested within a week after the first winged adults were observed. At the same time, early planted corn was tasseling; therefore, it escaped the buildup of aphid colonies in the whorl.

PLANT TAGGING

In 1968, a project similar to that reported two years ago was carried out to determine the gross yield losses caused by a heavy infestation of corn leaf aphid. Heavily infested plants were tagged in twenty-two fields. For each heavily infested plant tagged, a relatively clean plant was tagged near it. One hundred each of heavily infested and clean plants were tagged in each field.

In the fall, the plants were hand-harvested and dried. The yield from each plant was then graded into three categories: good ears, nubbins, and plants producing no kernels.

COMPARISONS

The results of the 1968 comparisons of clean and heavily infested plants are given in Table 1, as well as the 1966 results. For the clean plants, 1968 data show 92.4 percent of the plants yielded good ears; 4.8 percent, nubbins; and 2.8 percent, without kernels. The heavily infested plants yielded 63.1 percent good ears, 22.3 percent nubbins, and 14.6 percent without kernels.

When these figures are compared with the 1966 results, the following points are evident:

1. There were fewer barren plants or plants without any yield among the heavily infested plants in 1968 than in 1966 (14.6 percent compared with 33.7 percent).

2. The range between fields was narrower for both the heavily infested plants and the clean plants in the three categories of yield.

Shelled weights were taken on all harvested samples. The yield of the heavily infested plants was 27 percent less than the yield from the clean plants (Table 2).

Corn leaf aphid populations were given a rating in each of the 22 fields. These ratings were divided into four categories: clean plants, light infestation, moderate infestation, and severe infestation (Table 3).

Table 1. Percent Ear Yield of Noninfested Plants and Plants Heavily Infested by Corn Leaf Aphids, 22 Fields, 1966 and 1968

	Percent noninfested plants				Percent infested plants			
	Average		Range		Average		Range	
	1966	1968	1966	1968	1966	1968	1966	1968
Good ears	84.3	92.4	46.0-100	79.5-98.4	36.5	63.1	10.2-90.6	20.5-94.5
Nubbins	14.8	4.8	0-51.1	1.0-13.7	29.9	22.3	9.4-53.1	4.2-51.5
Plants without kernels	.9	2.8	0-5.1	0-8.7	33.7	14.6	0-70.4	0-42.0

Table 2. Yield Losses for Plants Heavily Infested by Corn Leaf Aphids Compared with Yields from Clean Plants, 22 Fields, 1966 and 1968

Year	Percent yield loss		Average percent field loss for heavily infested plants
	Average	Range	
1966	54	12-80	9.7
1968	27	3-68	2.2

Table 3. Percent of Corn Plants in Various Categories of Infestation by Corn Leaf Aphid, 22 Fields, 1968

	Average	Range
Clean plants	51	18-82
Light infestation	33	8-52
Moderate infestation	8	2-24
Heavy infestation	8	2-16

Table 4. Yield of Six Corn Varieties, Treated and Untreated for Control of Corn Leaf Aphid, 1968

Variety number	Bushels per acre		Difference
	Treated	Untreated	
1	108.0	80.8	27.2
2	119.8	105.8	14.0
3	104.4	91.0	13.4
4	128.8	117.5	11.3
5	106.1	99.6	6.5
6	131.7	134.8	+3.1
Average	116.5	104.9	11.6
			9.9% loss

Some conclusions can be drawn from a comparison of the two years:

1. The percent of aphid infestation in a field at early tassel was generally much higher in 1968 than in 1966.

2. Many more plants had a light- and moderate-infestation rating during pollen shed in 1968 than in 1966. In 1968, some fields had 80 percent or more infestation, with only 8 to 12 percent rated as heavily infested.

3. Even though plant populations in a field were higher in 1968 than in 1966, there appeared to be less stunting of the heavily infested plant, except in one field, where there was a severe grass problem and therefore not so much barrenness in a field.

4. The tagging was done from August 5 to 14, and aphid populations began to decrease rapidly after August 8. But at that time, there appeared to be a sizable difference among corn varieties, even in the same field, in the degree of infestation.

TREATMENT RESULTS

In one field, a portion of each hybrid was treated to control corn leaf aphids. Table 4 shows the differences in yield between treated and untreated portions among six of the hybrids. The field was treated with 1 pound of actual malathion with ground equipment. The corn plant was in the early tassel stage when treated on July 22. All varieties appeared to have similar infestations on this date, with about 60 percent of the plants being infested. Tagged plants in variety 2 of the list in Table 4 showed that there was about the same percent of yield loss on the heavily infested plants, whether treated or not treated, the loss being slightly higher in the untreated--19.7 compared with 23.1 percent (Table 5). In this field on August 5, the date the plants were tagged, the rating in the untreated area of variety 2 was as follows: 24 percent relatively clean plants, 52 percent lightly infested, 18 percent moderately infested, and 12 percent severely infested. The other five varieties were not rated as to degree of infestation in the untreated portions on August 5.

Table 5. Plant Yield Rating and Yield Loss. Treated and Untreated Plants of Variety 2 in Table 4

	Treated		Untreated	
	Uninfested	Heavily infested	Uninfested	Heavily infested
Good ears	86	56	95	62
Nubbins	11	39	3	36
Without kernels	3	5	2	2
Yield loss		19.7%		23.1%

CONCLUSIONS

The following conclusions can then be drawn from the data on the field treated for corn leaf aphid control, keeping in mind that they are based on only six hybrids and one year's results:

1. Yield losses from corn leaf aphids can vary with hybrid corn varieties.

2. Treatment with malathion as soon as the whorl had opened gave good kill and prevented further loss of yield for five out of six varieties, with the highest saving being 27 bushels per acre.

3. The field was treated in the early tassel stage on July 22, yet some damage had already occurred to the heavily infested plants.

4. Since the treated and untreated heavily infested plants had similar yields, the yield difference must have resulted from the moderately infested plants increasing in aphid populations in the untreated strips.

NOTE OF THANKS

We wish to thank the Extension advisers in Brown, Ford, LaSalle, Logan, and Mclean counties for their assistance; also James Sloan, Fuller Seed Company, Lincoln; Ollie Myers, Lexington; and Paul Heinhorst, A.B. Christman Fertilizer, Meredosia.

WEED CONTROL FOR CORN WITH MINIMIZED TILLAGE

E.L. KNAKE

The recent development of new equipment for reducing tillage and the surge of interest in minimized tillage methods call for coordinating weed control with these new practices.

REDUCING SEEDBED PREPARATION

There are several ways of reducing seedbed preparation: (1) pulling a field cultivator in front of the planter, (2) using a chisel plow, (3) using a till planter (such as the Buffalo Till Planter), (4) using a rotary tiller (such as the Side Winder) to prepare strips 8 or 10 inches wide to plant in, and (5) using a planter such as the Allis Chalmers No-Til Planter with fluted coulters to plant directly in unprepared stubble or dead soil.

One of the easiest ways to assure a good seedbed and to set the stage for good herbicide performance is to use conventional tillage. You can "cover up" any mistakes fairly easily with conventional tillage, although the costs and time required are a little higher. It takes very careful management with the new systems, but you can make them work.

Soybean stubble. This is one of the easiest places for trying reduced tillage. One disking or a field cultivator in front of the planter may be all the tillage you really need. But our research indicates that at least one tillage operation is desirable to control any existing vegetation and to allow the herbicide to penetrate into the soil a little better. It is difficult for the herbicide to get into a somewhat crusted or compact surface that is not worked.

If we fall-plowed only corn stubble and left the soybean stubble until spring, we would have much less dust in the air and less soil in the road ditches during the winter. But plowing soybean stubble is one way to use up the time between soybean and corn harvest.

Corn stubble. This is not plowed under where chisel plows, no-till planters, or other similar equipment is used. The crop residue left on the surface may intercept some of the herbicide as it is applied, and this does not help matters any. But as long as the soil is disturbed enough to obtain initial weed kill and to allow the herbicide to get to the new weed seedlings, control can be achieved. Such tillage systems do preclude much incorporation of herbicides, insecticides, or fertilizers before planting.

Where a moldboard plow is not used, perennial weeds can become more serious. Herbicide residues may be a greater problem without the dilution obtained by more-thorough tillage.

Sod planting. This practice has been successful with proper equipment, careful management, and the use of herbicides to kill both the old vegetation and the new crop of weeds. We have often found that it is important to kill the sod before planting. Spraying and planting at the same time may not be satisfactory unless a "quick-kill" herbicide is used. With sod planting, added care is sometimes needed to control insects.

Strip tillage. This method can be used in various kinds of stubble or in sod. The principle is to carefully prepare a strip 8 or 10 inches wide to plant in, and not prepare the rest of the area between the rows. A preemergence herbicide with good selectivity can be used on the prepared strip. A less-selective and perhaps lower-cost herbicide or combination can be used between the rows to kill existing vegetation and to provide residual control.

Double cropping. This scheme seems to have some potential in the southern part of Illinois where some of the early wheat varieties can be harvested soon enough to permit planting corn or soybeans in the stubble. There is some risk in dry years, and we could use short-season corn hybrids with more heat and drouth tolerance. But we have suitable planting equipment and appropriate herbicides.

SELECTING HERBICIDES

Selecting the herbicides best adapted to each individual method or situation is one of the keys to success. We often need herbicides to control both the existing vegetation and the weeds that will begin growing later. Consider the nature of the vegetation--both size and species.

For quick kill of sod, Paraquat has been useful. Amitrole, atrazine, and Lorox are also possibilities for some types of sod, but they give a slower kill. Dowpon might be used if it could be applied early enough to allow sufficient chemical breakdown and avoid crop injury.

Where broad-leaved plants are the major problem, consider 2,4-D, atrazine, or atrazine and oil. Applying atrazine plus oil preemergence to the corn but postemergence to the weeds might fit well. Banvel may be useful and practical when applied before nearby soybeans are planted.

Lorox offers a lot of versatility, since it can be used to control existing vegetation as well as to provide some preemergence control. Crop tolerance is close, though, so Lorox needs to be managed carefully. Atrazine plus Lorox is another possibility. Dinitro may fit in, mainly for some contact effect to "burn down" existing vegetation.

Wherever feasible, take advantage of surfactants and additives. These enhance activity, allow lower rates, and reduce costs: surfactant WK for Lorox, X-77 for Paraquat, and crop oil for atrazine.

Be on guard to add a second punch if the first application is not adequate. If a new problem appears, catch it early. If a broadleaf problem develops, try 2,4-D. If a grass problem develops, consider a directed application of Dowpon or Lorox. If cultivation is feasible, use it to control weeds early, before they gain a foothold.

Maintain versatility to handle any specific situation by taking full advantage of the wide selection of herbicides available.

THE SOYBEAN CYST NEMATODE

D.I. EDWARDS

GENERAL BACKGROUND

The soybean cyst nematode (SCN), *Heterodera glycines*, was first discovered in Japan in 1915, in Korea in 1936, and in Manchuria in 1938. The initial discovery of this pest outside Asia occurred in 1954 in New Hanover County, North Carolina. Two years later, it was found in Tennessee and Missouri. By 1959, it had been discovered in Arkansas, Kentucky, Mississippi, Virginia, and Illinois. More recently, infestations have been found in southern Indiana (1966) and in Florida and Louisiana (1967).

Despite strict quarantine regulations, SCN has continued to spread within infested areas. Losses have reached an all-time high during the last few years. In Missouri alone, the infested area went from 438,959 acres in 1966 to 781,455 in 1967. The estimated number of bushels lost increased from 1,160,000 in 1966 to 2,667,120 in 1967. A recent estimate indicates that this nematode may reduce soybean production by as much as 30 million bushels, causing a loss of approximately 3.7 percent of all soybeans grown in this country.[1/]

In individual fields, SCN losses may range from light to over 90 percent, depending on the level of infestation and the growing conditions. Losses will be more severe under conditions of low fertility or drought. The most striking damage usually occurs in light, sandy soils; but there has also been severe damage in heavy soils in the Mississippi Valley.

Soybeans grown in heavily infested soil are stunted and may undergo yellowing, which progresses upward from the bottom leaves. Young plants may die during periods of moisture stress. Often, nodulation is reduced and roots are extremely rotted. In addition, SCN may increase the incidence of infection by other soil pathogens. Unfortunately, the symptoms produced by SCN closely resemble those of other pathogens. The only specific sign is the presence of the white-to-brown, spherical females--slightly smaller than a pinhead--attached to the roots.

In a series of cooperative experiments at Jackson, Tennessee; Beltsville, Maryland; Holland, Virginia; and Raleigh, North Carolina, the presence of biotypes, or physiological races of SCN, has been established. These can be differentiated on the basis of the population development on resistant varieties, the stunting and chlorosis of plants, and the morphological variations of second-stage larvae.

CONTROL

The control of SCN in the United States has been centered around the use of crop rotations, resistant varieties, and quarantine. Although chemicals have been used experimentally with some degree of success, they are not economical for extensive use by growers, because of the cost and the necessity for annual application.

1/ Good, J.M. (1968) *Assessment of Crop Losses Caused by Nematodes in the United States*, FAO Plant Protection Bull. 16(3):37-40.

During the 1968 growing season, field tests were initiated in Franklin County, Illinois, to study the control of SCN by the use of crop rotation and chemicals. The performance of resistant versus susceptible varieties was also studied.

Crop rotation. On heavily infested land, susceptible soybean varieties cannot be grown two years in succession without drastic yield reductions. However, yields comparable to those normally expected in a region can be maintained by growing nonhost crops (such as corn, small grains, and cotton) for 1 to 5 years, depending on the severity of the infestation. Recommended crop-rotation periods have resulted from experimental work done in Tennessee and North Carolina. Whether these recommendations are optimum for Illinois conditions and cultural practices will be determined in the long-range, crop-rotation experiment now underway in Franklin County.

For rotation to be effective, the weed hosts of SCN must be recognized and controlled. Such weeds as henbit deadnettle, mouse-ear and common chickweed, beardstongue, and common Mullen have been reported as hosts. During the past summer, thirteen weed species, commonly found in soybean fields in southern Illinois, were dug from infested fields and examined for the presence of cysts on the roots. No new hosts were encountered.

Resistant varieties. Approximately 3,500 soybean strains from the germ plasm collection have been evaluated for resistance to SCN. From these tests, only two black-seeded types, Peking and PI 90763, were found to be resistant. Using Peking as the resistant parent, crosses were made with good agronomic varieties and breeding types. As results of this program, there are three SCN-resistant varieties: Custer (Group IV), Dyer (Group V), and Pickett (Group VI). Custer, released in 1967, is the only resistant variety adapted to the most-northern of our infested areas. The U.S. Department of Agriculture and the Missouri Agricultural Experiment Station are conducting cooperative research intended to develop resistant varieties that will mature earlier.

On heavily infested soil in Franklin County, Illinois, the resistant variety, Custer, yielded an average of 38.1 bushels per acre, compared with 5 to 10 bushels per acre for standard susceptible varieties (Clark-63, Scott, Wayne, and Kent). These yield data clearly demonstrate the ability of the cyst nematode to reduce soybean yields so that they are not economical to grow. However, use of resistant varieties essentially eliminates the damage.

Chemical control. If the development of resistant varieties does not keep pace with the northward advance of SCN, then chemical control must be considered as an alternative to crop rotations. Our best available nematocides do not give 100-percent control of the cyst nematode; however, some will give two- to threefold increases in yield over nontreated, susceptible varieties. Screening new chemicals or new formulations or dosages of standard ones is part of the experimental program now in progress at Illinois as well as other states.

BEHAVIOUR OF INSECTICIDES IN SOIL

C.R. HARRIS

Soil insects are serious agricultural pests in many areas of the world. In North America, several species are of importance. These include the corn rootworm, numerous species of cutworms, wireworms, root maggots, and white grubs.

Prior to World War II, soil-insect control was considered to be an enormously difficult problem. The only material that seemed to provide anywhere near the degree of control required was lead arsenate. However, with the introduction of DDT in the late 1940's and materials such as aldrin and heptachlor in the early 1950's, the problem of controlling soil insects became a thing of the past. These new insecticides, particularly aldrin and heptachlor, were remarkably active in soil, and worked wonders against virtually all the species of soil insects of economic importance. We made "blanket recommendations" for controlling the "soil-insect complex." In retrospect, it is apparent that we misused these extremely good materials. The end result was the development of insecticidal resistance by many species of soil insects, and the needless contamination of large acreages of our agricultural lands with residues of DDT, aldrin, dieldrin, heptachlor, and heptachlor epoxide. The use of these materials is now severely restricted. Consequently, we have been forced to look for alternative insecticides for soil-insect control. It rapidly became apparent that the alternative insecticides available, i.e. the organophosphorus and organocarbamate insecticides, were not nearly as effective in soils as the organochlorine insecticides, and even those which were effective provided erratic results from one year to the next. Therefore, we were forced to investigate the factors influencing the activity of an insecticide in soils.

BACKGROUND INFORMATION

In developing this discussion, I have attempted to avoid placing too much detail on any one factor. As a result, much of the data shown in the tables is the result of screening tests, rather than more accurate LD_{50} estimations. All of the results shown here are from laboratory studies. I have selected five insecticides to serve as examples. Two are common organochlorine insecticides (aldrin and DDT), one is a common organophosphorus insecticide (diazinon), one is an experimental organophosphorus compound (Dursban), and one is an experimental carbamate (Lannate).

INSECTICIDES & SOIL TYPES

I would like to begin the discussion with data showing the direct-contact toxicity of the five insecticides to first-instar nymphs of the common field cricket. In these tests, the insecticide solutions were applied directly to the insects using a spray tower. As you can see from the results in Table 1, the five materials were equitoxic to the crickets at the 0.01-percent concentration.

Remember this point--all the materials were equally toxic to the first test insect used. Now watch what happens.

In tests with a second species of insect (in this case, adults of the seed-corn maggot), somewhat different results were obtained. Three of the test materials were equitoxic at the 0.01-percent concentration (Dursban, diazinon, and aldrin), but the other two materials (Lannate and DDT) were only 1/10 as toxic (Table 2).

Table 1. Lowest Concentrations Showing Biological Activity when Applied as Direct-Contact Applications (Crickets) a/

Percent insecticide solution		
.001	.01	.1
...	Dursban Lannate diazinon aldrin DDT	...

a/ Twenty-four-hour mortalities.

Table 2. Lowest Concentrations Showing Biological Activity when Applied as Direct-Contact Applications (Seed-Corn Maggot Adults) a/

Percent insecticide solution		
.001	.01	.1
...	Dursban diazinon aldrin	Lannate DDT

a/ Twenty-four-hour mortalities.

With a third species of insect (the black cutworm), different results were again obtained (Table 3).

Table 3. Lowest Concentrations Showing Biological Activity when Applied as Direct-Contact Applications (3-4 Instar Black Cutworms) a/

Percent insecticide solution			
.001	.01	.1	1.0
...	...	Dursban aldrin Lannate diazinon DDT	...

a/ Forty-eight-hour mortalities.

In this experiment, Dursban, aldrin, Lannate, and diazinon were all more or less equitoxic. Generally speaking, however, they were about 1/10 as toxic to cutworms as they were to crickets and flies. The point I am making here is that insecticides are not equally toxic to all species of insects. In one instance, a compound may be highly effective; in the next, it will be of little practical value.

If we refer back to Table 1 for a moment, I would like to point out again that the five insecticides--Dursban, Lannate, diazinon, aldrin, and DDT--were all equally toxic when applied directly to first-instar cricket nymphs. However, when these same insecticides (which, incidentally, were all 95- to 99-percent purity) were incorporated into a moist sandy loam soil, an entirely different picture resulted (Table 4). The most toxic material was aldrin; Dursban and diazinon were 1/5 as toxic; DDT, 1/50 as toxic; and Lannate, 1/500 as toxic.

Table 4. Lowest Concentrations Showing Biological Activity in Moist, Sandy Loam (Crickets)

PPM in soil					
0.1	0.5	1	5	10	50
aldrin	Dursban diazinon	...	DDT	...	Lannate

ADSORPTION

This is an excellent sample of the phenomenon of adsorption and the manner in which it can alter insecticidal activity. Aldrin was least strongly, Dursban and diazinon slightly more strongly, DDT moderately strongly, and Lannate very strongly adsorbed and inactivated by the moist sandy loam. Therefore, not only are insecticides adsorbed by soil, but the degree of adsorption will depend on the affinity of the soil colloids for each specific compound.

In addition, the adsorptive capacity of the soil will vary, depending on the soil type. In Table 5, the activity of the same insecticides is compared in moist, sandy loam and in muck. As you can see, Lannate, which is water soluble, was strongly adsorbed in both sandy loam and muck, and there was no difference in activity. Dursban was only 1/2 as effective in muck as in sandy loam, i.e. it was not strongly adsorbed in organic soil. However, DDT was 1/20, aldrin 1/50, and diazinon only 1/100 as effective in muck as in sandy loam. It is apparent that soil type has a pronounced influence on the biological activity of insecticides, and that the degree of adsorption again will depend on the specific chemical involved. From more-detailed studies, we have found that in moist soils, biological activity is proportional to the percent of organic matter present. In dry soils, while organic content is still important, the organochlorine insecticides are also strongly absorbed by clays; other compounds, such as diazinon, are most strongly absorbed in sandy soils.

Table 5. Influence of Soil Type on the Biological Activity of Insecticides (Crickets)

Insecticide	PPM in soil showing insecticidal activity: Sandy loam	Muck	Ratio: sandy loam to muck
Lannate	50	50	1
Dursban	0.5	1	1/2
DDT	5	100	1/20
aldrin	0.1	5	1/50
diazinon	0.5	50	1/100

WATER REACTIONS

In addition to soil type, the reactions of water in soils and their effect on the behaviour of pesticides are also of major importance. The influence of soil moisture on insecticide bioactivity is shown in Table 6. The biological activity of Lannate was not influenced by soil moisture. Aldrin, Dursban, and DDT were 1/10 as active in dry as in moist soil; diazinon was 1/100 as active. The effect of soil moisture will also vary with soil type. In soils high in clay minerals, the organochlorine insecticides are more-strongly influenced by soil moisture. In soils high in organic matter, there is little obvious moisture effect.

Table 6. Influence of Soil Moisture on the Biological Activity of Insecticides in Sandy Loam (Crickets)

Insecticide	PPM in soil showing insecticidal activity: Moist	Dry	Ratio: moist to dry
Lannate	50	50	1
aldrin	0.1	1	1/10
Dursban	0.5	5	1/10
DDT	5	50	1/10
diazinon	0.5	50	1/100

SOIL TEMPERATURE

Soil temperature is also a factor that will influence insecticide bioactivity (Table 7). In moist sandy loam, aldrin was only 1/3 as effective at 60° as at 90° F. Similarly, Dursban and Lannate were 1/2 as toxic, while diazinon was 2/5 as toxic. DDT, which normally exhibits a negative temperature coefficient, was twice as effective at 60° as at 90° F. In comparison to the other factors of soil type and moisture, temperature appears to be of less importance. However, the temperature effect is moderated by the presence of soil moisture, since increased moisture content results in desorption of the insecticide from the soil. In dry soils, therefore, where insecticide adsorption is greater, the temperature effect is much more pronounced. For example, in the moist sandy loam, aldrin was 1/3 as effective at 60° as at 90° F. (Table 5). But, in dry sandy loam, we have found it to be only 1/5 as effective.

Table 7. Influence of Soil Temperature on the Biological Activity of Insecticides in Moist, Sandy Loam (Crickets)

Insecticide	PPM in soil showing insecticidal activity: 90° F.	60° F.	Ratio: 90° to 60° F.
aldrin	0.1	0.3	1/3
Dursban	0.2	0.4	1/2
diazinon	0.4	1	2/5
Lannate	20	40	1/2
DDT	4	2	2

VOLATILITY

One of the characteristics of a good soil insecticide is that it should be moderately volatile. Vaporization not only results in a more-rapid disappearance of the residue, but the insecticide vapors penetrating through the soil will also result in fumigant toxicity to the soil insects. Hence, it is interesting to compare the fumigant toxicity of the five materials in question, measured by placing the test insects above a treated glass surface and treated soil. As shown in Table 8, aldrin, Dursban, diazinon, and Lannate were all moderately volatile on a glass surface, while DDT was not. However, in soil, aldrin was most volatile; Dursban only slightly less so. Diazinon was slightly volatile, while Lannate and DDT were nonvolatile. Thus, the more strongly an insecticide is adsorbed by soil, the less likely it is to be volatile.

Table 8. Fumigant Activity of Insecticides on a Glass Surface and in a Moist, Sandy Loam (Crickets)

Insecticide	Fumigant activity: Glass surface	Fumigant activity: Sandy loam
aldrin	***	***
Dursban	***	**
diazinon	***	*
Lannate	***	...
DDT	...	...

PERSISTENCE

A key factor influencing insecticide bioactivity is, of course, the persistence of the insecticide in the soil. Table 9 illustrates results we obtained with the same five insecticides in a series of tests done in the laboratory under controlled conditions. As you can see, the biological activity of DDT persisted up to the end of the 36-week period during which the test was conducted. Thus, DDT would be classed as a highly persistent compound. The biological activity of both aldrin and Lannate, for all practical purposes, disappeared in 16 weeks. These compounds were classed as moderately persistent. The bioactivity of Dursban and diazinon disappeared after 2 weeks. Thus, these materials would be classified as short residual compounds.

Table 9. Persistence of Biological Activity in a Sandy Loam Soil Under Controlled Conditions (Crickets)a/

Insecticide	PPM in soil b/	Period measured (weeks) 0	2	4	8	16	24	36
DDT	24	100	100	100	100	90	85	95
aldrin	0.8	100	94	97	77	12	2	2
Lannate	60	100	100	100	82	27	2	0
Dursban	1	100	57	0	0	0	0	0
diazinon	1.6	100	43	0	0	0	0	0

a/ 80° F. constant light, optimum moisture, uncovered containers.
b/ LD_{100} times 2.

CONCLUDING COMMENTS

These results show that the behaviour of an insecticide in soil is dependent on a number of factors. The toxicity of each will vary according to the species of insect with which we are concerned. The physical-chemical characteristics of each specific insecticide will influence the degree of adsorption of the insecticide by the soil, its volatility, and its persistence. In addition, soil and climatic factors are of major importance, i.e. soil type, moisture, and temperature.

From the data shown herein, we have learned a great deal about the reactions of these five insecticides in soil. Initially, all were effective contact poisons. Aldrin was remarkably uniform in activity. It was least-strongly adsorbed in mineral soil, quite-strongly adsorbed in muck soil, only slightly inactivated with low soil moisture and temperature, moderately volatile and moderately persistent. Dursban also presented a remarkably uniform picture, but was a very short residual compound. DDT was adsorbed by soil in a moderately strong manner, but otherwise reacted in a fashion similar to aldrin. Lannate was so strongly adsorbed under all circumstances that it was virtually ineffective. Among the most interesting results were those obtained with diazinon, which was as effective as Dursban in moist, mineral soil but was very strongly adsorbed and inactivated in dry, mineral soil and in muck soil. It is likely that these results explain the erratic control obtained with diazinon under certain soil and climatic conditions.

The search for alternative soil insecticides to replace aldrin and heptachlor is one which will be both difficult and time-consuming. However, now that we have some basic information on the factors that influence insecticide behaviour in soil (and at the same time have developed some effective techniques for screening soil insecticides), the search becomes much easier. Effective new soil insecticides are being developed. Some have been registered for use in the past year, and others are only 1 or 2 years away from registration. We must, however, be careful in the future, to utilize our new soil insecticides more efficiently and realistically, in order to avoid the type of problems that have developed as a result of the extensive use and misuse of aldrin and heptachlor.

INJURY FROM 2,4-D

F.W. SLIFE

During each of the previous twenty spray schools, we have talked about the use of 2,4-D and the associated problems. This year is no exception. During the past growing season (1968), some cornfields were severely injured by 2,4-D. The injury resulted primarily from treatment to corn when it was very small, and after a three-week period of cold, wet weather. There was some severe onion-leafing. Some fields failed to develop normal ear shoots, hence yield reductions were severe. The unfortunate thing is that this type of injury is not predictable, and it may or may not happen again.

2,4-D--A HIGHLY VARIABLE COMPOUND

Many people who work with herbicides would conclude that 2,4-D is one of the most variable compounds in use today. It can give variable results from the standpoint of weed control and also of crop injury. These variables seem to be controlled by environment, but are also affected by the rate of chemical used.

2,4-D appears to affect all types of plants; therefore, its selectivity is relative to the rate applied. At high enough rates there is no selectivity, but at 1/2 pound per acre, we kill most broad-leaved annual weeds without hurting corn too much. As already mentioned, the results are variable in terms of weed control and corn injury when we apply these lighter rates. This variation seems to be caused by the amount of 2,4-D that enters the plant and by the rate of movement and degradation of the material that has entered.

Our studies show that as little as 30 percent of the 2,4-D that falls on a leaf enters within 24 hours. This is especially true under dry conditions with low humidity. Under humid conditions, it is possible for as much as 60 percent of the applied 2,4-D to enter the plant. The thickness and permeability of the cuticle are greatly affected by the environment. All plants degrade 2,4-D after it has passed the cuticle barrier. The rate of degradation varies with the particular species, and is undoubtedly affected by temperature and other plant processes. We have found that at the end of 24 hours, cocklebur can degrade only 5 percent of the 2,4-D that enters the leaf. On the other hand, wild cucumber can degrade 75 percent within a 24-hour period.

CORN AND 2,4-D

Corn is very similar to a resistant broad-leaved weed in that under normal conditions, the rate of penetration is low and the rate of degradation is high. This results in a very small amount of free 2,4-D in the plant, and it is translocated out of the leaf and into the stem area. It then moves to the meristems, or rapid-growth area, at each node. This small amount of 2,4-D will frequently stimulate these meristems to grow faster than normal, with the result that we have stalk brittleness. In some plants, it affects the developing leaves; when these emerge several weeks later, they may grow together to produce onion-leafing.

Many of the corn fields injured by 2,4-D in 1968 were in an ideal condition to allow maximum penetration of 2,4-D. The weather was cold and wet prior to treatment, and the cuticle poorly developed. In addition we would have to assume that the rate of degradation in the plant was low because of low temperatures. Regardless of the causes, 2,4-D in considerable quantities ended up in the nodal areas. Since much of it was applied to small corn, it had the opportunity to affect ear-shoot development; also, the new leaves that were being formed at that time. The results were some fields of severe onion-leafing, others with very poor seed set.

POSSIBILITIES FOR INJURY

Although there is some variety variation with 2,4-D, there was little or no correlation of injury and varieties in 1968.

The incidence of injury to corn can be reduced by using proper rates and good spray patterns, keeping as much 2,4-D off corn as possible, and not spraying corn under severe stress conditions. Even with these precautions, the possibility of injury cannot be eliminated.

Because of this factor, farm operators should consider alternate methods of broad-leaved weed control in corn. This can be achieved with preplant or preemergence herbicides. At this point, we believe that atrazine at 1 pound or less with an additive could be an adequate replacement.

WHY CHEMICALS FAIL TO CONTROL CUTWORMS

C.R. HARRIS

The failure of insecticides to control cutworms is one of the most vexing problems facing soil-insect entomologists today. In the past, the organochlorine insecticides (particularly aldrin and heptachlor, and to a lesser extent, DDT), provided excellent control of most species of cutworms. However, residue problems have severely limited the use of these compounds for cutworm control now. Unfortunately, we have not, as yet, been able to find truly satisfactory alternative materials or methods of cutworm control. Materials that appear promising for the control of soil-insect species simply do not work well against cutworms. Consequently, we have been attempting to determine exactly why chemicals fail to control cutworms for the past three years in our laboratory.

THE PROBLEM

In southwestern Ontario, we have 3 cutworm species of major economic importance. In tobacco, a crop worth $150 million to us, the dark-sided cutworm is the major insect pest. We estimated that this species was causing approximately $10 million in damage each year, prior to the development of an adequate control program in 1967. In other crops, there are 2 species of major economic importance--the black cutworm and the variegated cutworm. At the present time, we do not have adequate control measures for either of them.

In our laboratory, we have been working extensively on all 3 species. The results, which I will show, are a combination of tests conducted on each species. I hope you will be able to follow me as I switch from one species to the next.

In the previous discussion on the behaviour of insecticides in soil, I mentioned a number of basic factors that influence insecticidal activity in soil. These included: (1) the toxicity of the specific insecticide to the particular species of insect involved; (2) the influence of soil type on toxicity; and (3) the influence of climatic factors, such as soil moisture, on toxicity. Naturally, these basic factors apply directly to cutworm control, and I would like to demonstrate their importance.

OUR APPROACH TO THE PROBLEM

Before we begin worrying about the effectiveness of an insecticide in soil, we must be certain that the material is toxic to the insect species involved. During the past three years, we have screened approximately 50 candidate insecticides in our laboratory against the 3 species of cutworms with which we are concerned. Only a very limited number were toxic to cutworms; I will not bother to list the materials we have tested that were ineffective. However, a few materials did appear to be fairly promising, compared to the "standard insecticides"--aldrin and DDT (Table 1). In the case of the black cutworm, Dursban, Lannate, Bay 37289, or DDT were all equivalent in toxicity to aldrin. With the variegated cutworm, Lannate, DDT, and Dursban were equitoxic to aldrin, while Bay 37289 was 1/10 as toxic. In the case of the dark-sided cutworm, Dursban was 10 times as effective as DDT, Bay 37289 and Lannate were equitoxic to DDT, and aldrin was 1/10 as toxic as DDT. Thus, as you can see, the toxicity of the various insecticides varies considerably, depending on the species of cutworm involved. Another important factor, as can be seen in Table 1, is that the general toxicity of all the insecticides was from 1/10 to 1/100 that obtained against crickets. In other words, cutworms are naturally tolerant in the 3-4 instar of the larval stage to all insecticides.

Table 1. Lowest Concentration of Some Insecticides Showing Biological Activity to 3-4 Instar Larvae of the Black, Variegated, and Dark-Sided Cutworms, and to First Instar Cricket Nymphs

Insect	Percent insecticide solution .01	.1	1.0
Black cutworm a/	...	Dursban aldrin Lannate Bay 37289 DDT	...
Variegated cutworm a/	...	Lannate DDT Dursban aldrin	Bay 37289
Dark-sided cutworm a/	Dursban	Bay 37289 Lannate DDT	aldrin
Cricket nymphs b/	Dursban Lannate aldrin Bay 37289 DDT	...	...

a/ Forty-eight-hour mortalities.
b/ Twenty-four-hour mortalities.

The larval stage of the cutworm consists of six instars. In addition to screening numerous materials on 3-4 instar larvae, we decided to test the tolerance of the various larval instars to some of the more promising materials. Studies on the direct-contact toxicity of aldrin and Dursban to the various larval instars of the black cutworm are shown in Figure 1. A concentration of 0.1-percent Dursban killed 100 percent of the first-instar larvae; none of the fifth- and sixth-instar larvae. Similar results were obtained with aldrin. Hence from a practical point of view, the treatment must be applied when the larvae are still in the early stages of development. Since cutworm infestations are virtually impossible to predict, preventative control using preplanting treatments may be a more-satisfactory procedure than emergency control after the infestation has been noted--since in many instances (before the damage becomes apparent), the larvae are in the later instars. Results we have obtained with the dark-sided and variegated cutworms also indicate that these 2 species exhibit the same type of larval tolerance. This phenomenon is probably one of the major reasons why we so often fail to control cutworms with insecticide applications--we wait until it is too late and the larvae are too large to obtain effective kill.

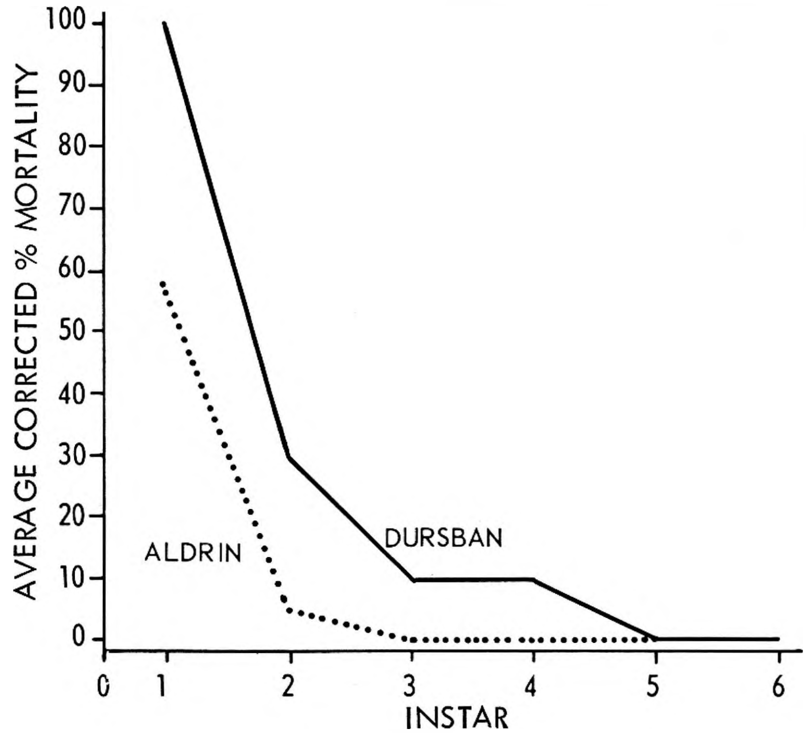

Figure 1. Direct contact toxicity of aldrin (0.1 percent) and Dursban (0.1 percent) to the various instars of the black cutworm.

SOIL ADSORPTION

As I pointed out in the previous paper on *Insecticide Behaviour in Soils,* the activity of an insecticide will depend on the extent to which that specific material is adsorbed by the soil. Using data obtained in studies with the variegated cutworm, I would like to demonstrate to you just how important this factor of adsorption can be. When tested against larvae of the variegated cutworm, Lannate, DDT, and Dursban were approximately equitoxic (Table 2). Some minor differences in toxicity were apparent, and the actual order of direct-contact toxicity was Lannate>DDT>Dursban. In the paper on *Insect Behaviour in Soils,* I showed you data indicating that Dursban was the most-effective soil insecticide, since it was the one least strongly adsorbed by soil. DDT was adsorbed in a moderately strong fashion and thus was only moderately effective. Lannate was very strongly adsorbed, consequently was ineffective as a soil insecticide. Thus, we would expect that even with cutworms, the order of toxicity would be reversed when the insecticides were applied to soil. As you can see in Table 3, this was indeed the case. Dursban provided complete kill in 48 hours at a rate of 1/4 pound actual per acre. DDT provided a similar degree of kill at 1 pound; Lannate, at 2 pounds actual per acre. Thus, we can clearly see the importance of adsorption of the insecticide by the soil. The most-toxic material as a direct-contact poison was least toxic in soil. It is also interesting to note that results we obtained with pure materials in the previous tests parallel those obtained with the technical formulation. Consequently, because of adsorption, Dursban became the most-promising soil insecticide against cutworms, Lannate the least-promising one.

Table 2. Lowest Concentrations Showing Insecticidal Activity as Direct-Contact Applications

[Third-Fourth Instar Variegated Cutworms[a/]]

Percent insecticide solution		
.001	.01	.1
...	...	Lannate DDT Dursban

a/ Forty-eight-hour mortalities.

Table 3. Toxicity of EC or Liquid Formulations as Surface Applications on Moist, Sandy Loam

[Third-Fourth Instar Variegated Cutworms]

	48-hr. pct. mortality			
	Rate of application--lb. actual per acre			
Insecticide	1/4	1/2	1	2
Dursban	100	100	100	100
DDT	83	94	100	100
Lannate	20	25	80	100

In other studies, however, we found that stomach poisons are far more toxic to cutworms than contact poisons. When rye plants were grown in the same soil and when the EC formulations of the three insecticides were sprayed on the rye rather than the soil, the results were entirely different. As shown in Table 4, DDT applied to rye was about 4 times as effective as the soil-surface application, Dursban did not show any marked increase in toxicity, but Lannate was at least 32 times more effective on the rye as on the soil.

Table 4. Comparison of the Toxicity of DDT, Dursban, and Lannate Applied as Residual-Contact Versus Stomach Poisons

[Third-Fourth Instar Variegated Cutworms]

		48-hr. average corrected pct. mortality					
		Rate of application--lb. actual per acre					
Insecticide	Method of poisoning	1/16	1/8	1/4	1/2	1	2
DDT	Soil surface	...	...	83	94	100	100
	Sprayed on rye	75	95	100	100	...	...
Dursban	Soil surface	...	...	100	100	100	100
	Sprayed on rye	70	85	100	100	...	...
Lannate	Soil surface	...	...	20	25	80	100
	Sprayed on rye	100	100	100	100	...	...

The results of this series of tests are illustrated in Figure 2. As direct-contact poisons, all of the materials were similar in toxicity. On the soil surface, Dursban was the one least adsorbed--thus, the most-effective one. DDT, which was strongly adsorbed, was markedly less effective. However, as stomach poisons, all the materials were effective, with the order of toxicity being Lannate>DDT>Dursban. The point I would like to bring out here is that method of application is of critical importance.

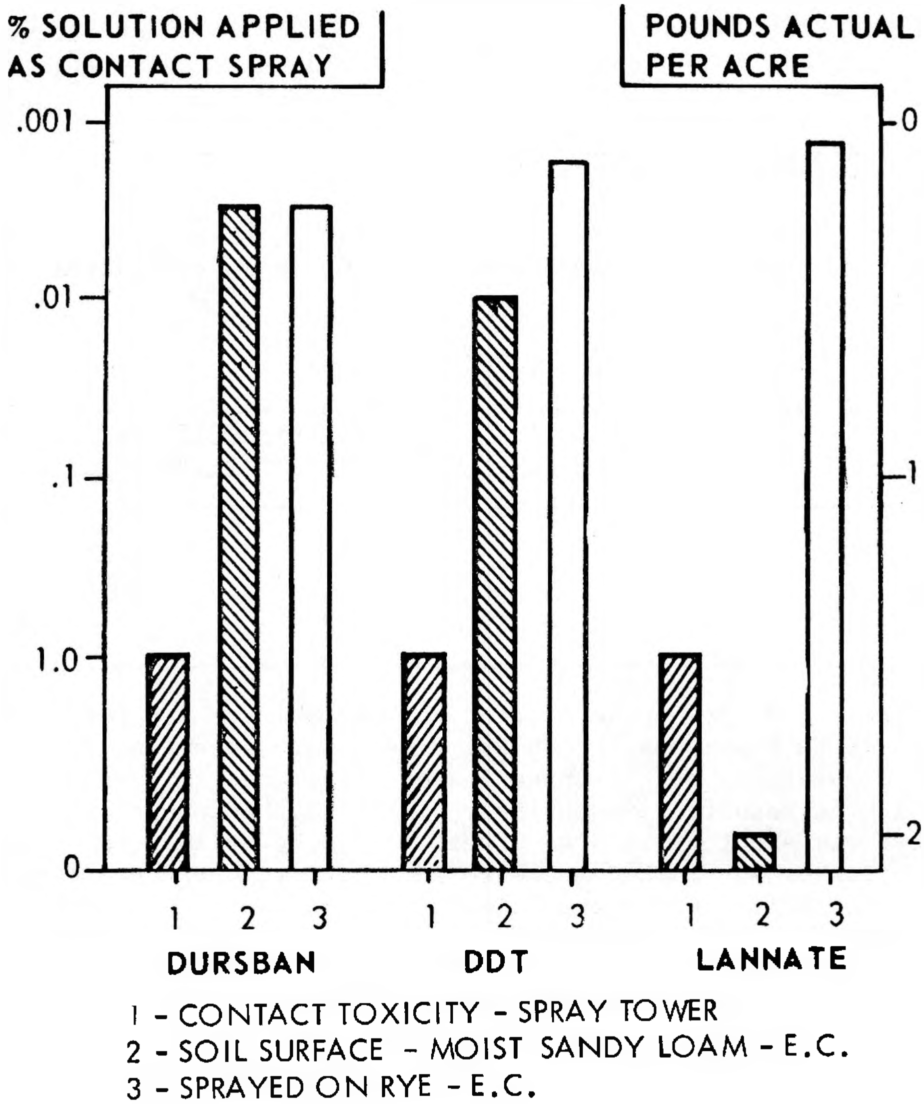

Figure 2. *Effectiveness of various methods of application on the toxicity of Dursban, DDT, and Lannate to third-fourth instar larvae of the variegated cutworm.*

SOIL TYPE AND MOISTURE

As I mentioned in the paper on *Insect Behaviour in Soils*, our basic research studies have indicated that both soil type and soil moisture have a pronounced effect on the toxicity of an insecticide in soil. We were interested to see what effect these two factors would have on cutworm control. Table 5 shows the importance of soil type to the toxicity of aldrin to 3-4 instar black cutworm larvae.

As you can see, soil type has a pronounced influence on the toxicity of an insecticide to cutworms. Aldrin as a soil surface application on moist, sandy loam was 2 times as effective as the surface application on moist muck. When it was incorporated into the soil, aldrin was 8 times as effective in the moist, sandy loam as in the moist muck.

The effect of soil moisture in relation to soil type on the toxicity of Dursban to 3-4 instar black cutworms is shown in Table 6. Again, soil moisture is of prime importance in the sandy loam. Dursban was 8 times as effective in the field moist soil, as in the air-dry soil. With the muck soil, moisture was apparently not a major factor influencing the activity of Dursban against cutworms.

Table 5. Influence of Soil Type and Method of Application on the Toxicity of Aldrin EC to 3-4 Instar Black Cutworms

		48-hr. pct. mortality				
	Method of	Rate of application--lb. actual per acre				
Soil type	application	1/4	1/2	1	2	4
Sandy loam	Surface	45	95	100	100	...
	Incorporated	71	100	100	100	...
Muck	Surface	25	40	80	95	...
	Incorporated	0	0	0	35	94

Table 6. Influence of Soil Moisture on the Toxicity of Dursban EC to 3-4 Instar Black Cutworms

		48-hr. pct. mortality			
		Rate of application--lb. actual per acre			
Soil type	Soil moisture	1/4	1/2	1	2
Sandy loam	Air-dry	39	56	61	83
	Field moist	83	100	100	100
Muck	Air-dry	11	22	72	100
	Field moist	12	76	94	100

FORMULATION

Formulation is also a factor of considerable importance. In tests with aldrin on 3-4 instar black cutworms, we assessed the efficiency of four formulations, both as surface applications and as soil incorporations (Table 7). On the soil surface the dust was most effective EC>WP>G. When incorporated into the soil, the EC was most effective>D>WP=G.

INSECT BEHAVIOUR

The final factor that I would like to mention is that of insect behaviour. In the studies we have done on the 3 species of cutworms--the dark-sided, black, and variegated cutworms--we have found some interesting comparisons of biological activity of DDT in relation to larval behaviour. As a contact poison, DDT is equitoxic to all of these species. However, in soils, the story is a different one (Table 8). The dark-sided cutworm burrows at a very early stage (third instar), and is commonly found in dry, sandy soils. The dry soils inactivate the insecticide. Consequently, we must apply 4 pounds per acre of DDT to obtain

Table 7. Toxicity of Aldrin[a/] Applied to Moist, Sandy Loam in Relation to Formulation

[Third-Fourth Instar Black Cutworms]

Formulation	Method of application	48-hr. percent mortality
5% D	Soil surface	45
EC		30
50% WP		0
5% G		0
5% D	Incorporated	45
EC		80
50% WP		15
5% G		15

a/ 1/4 lb. actual per acre.

adequate control. The black cutworm does not burrow until late third or early fourth instar, and is commonly found in moist soils. Here we need to apply only 2 pounds per acre to obtain the same degree of control. The variegated cutworm does not burrow until late fifth instar, and is also commonly found in moist soils. Here, less than 1/4 of a pound per acre is needed to be effective. Thus, there is at least a sixteen-fold difference in the toxicity of DDT as a soil treatment to these 3 species because of larval behaviour. In the past, in some areas, we have often recommended 4 pounds per acre of DDT as a "blanket application" for cutworm control. In one case, this rate was adequate; in the second, we were applying twice as much as was required; in the third, we were applying 16 times as much as was required.

Table 8. Toxicity of Surface Applications of DDT[a/] EC to Third-Fourth Instar Larvae of Three Species of Cutworms in Relation to Larval Behaviour

Species	Habits and behaviour	48-hr. pct. mortality				
		Rate of application--lb. actual per acre				
		1/4	1/2	1	2	4
Dark-sided	Burrows, dry sandy soil	...	10	20	68	84
Black	Burrows, moist soil	10	25	55	85	...
Variegated	Surface, moist soil	100	100	100	100	...

a/ DDT is equitoxic to all three species as a direct-contact poison.

RESULTS AND COMMENTS

The results of these studies clearly demonstrate "why insecticides fail to control cutworms."

First, the number of materials toxic to cutworms is extremely limited. The materials we have been using in recent years, such as Dylox and Sevin, are only moderately toxic to the larvae.

Second, we have been attempting to control the later rather than the early instars. Because of increasing tolerance to insecticides with each successive instar, it is extremely difficult to control these later ones. Preventative, rather than emergency controls, may provide the ultimate answer.

Third, we have not been applying our insecticides in the most-efficient fashion. Stomach poisons are far more effective than soil treatments in most instances. The development of attractive natural or artificial baits would provide one excellent method of cutworm control.

Fourth, where soil application is concerned, we have failed to consider either soil type or soil moisture when developing our recommendations. The amounts of insecticide recommended per acre as soil treatments should be related to the general soil type, the organic content, and the moisture content of the soil at the time of treatment.

Fifth, we have failed to consider the method of application. In some instances, e.g. sandy soils, best results will be obtained by incorporating the insecticide into the top 2 inches of soil. In the case of soils high in organic matter, best results will be obtained by applying the insecticide to the soil surface.

Sixth, formulation is a factor of major importance. Although granules are widely used for cutworm control, other formulations, e.g. dusts and emulsifiable concentrates, are more effective.

Finally, we have failed to consider the behaviour of the insect. The insecticide, the formulation, and the method of application must be related to the species of cutworm involved.

As practical people you might question the idea that the principles I have outlined will apply when the problem is actually tackled in the field. I would, therefore, like to take a few more minutes to describe to you the results we have obtained in applying our laboratory principles to the control of the dark-sided, black, and variegated cutworms in tobacco in southwestern Ontario.

The dark-sided cutworm has a single generation a year. The adults lay eggs in the late summer and early fall and these eggs go into diapause. They hatch in April, and the small larvae feed on the rye crop, which is grown in alternation with tobacco. The rye is plowed-down prior to planting the tobacco, and the cutworm larvae continue to feed. When the tobacco is transplanted, the larvae immediately attack the succulent young plants.

Previous attempts to control this cutworm in tobacco with DDT-bran baits and DDT soil treatments were a failure. Our approach to the problem was to attempt to kill the young larvae with a stomach poison. To do this, we sprayed the rye fields with insecticides late in April. The results we obtained were phenomenal. DDT at 1 pound per acre provided 100-percent control of the dark-sided cutworm, and this is our present recommendation. Other materials not yet registered for use are effective at rates as low as 1/2 ounce per acre, when applied as a rye treatment. To control the black and variegated cutworms that appear later in May and June, we use a preventative, preplant soil treatment of DDT. Again, other experimental materials show promise but are not yet registered for use. We are finding that the principles of cutworm control we have developed in the laboratory are sound when applied in the field. It is simply necessary to work out the proper combinations for control of a particular species of cutworm in relation to the soil type, climatic conditions, and crop involved.

GARDEN SYMPHYLANS--
A NEW PEST OF CORN ROOTS

R.E. SECHRIEST

The garden symphylan is not new to Illinois. Specimens were found as early as 1949 in forest litter and Andropogon sod (Figure 1). Only in the last three to four years has this animal become an economic pest in Illinois corn.

The garden symphylan is a small, white "centipede-like" animal with long antennae. The "gut" usually appears as a dark streak through the body. These animals may become as large as 5/16 of an inch long. They move so rapidly that they are very difficult to capture, and they disappear into the soil within seconds when disturbed.

METHOD OF ATTACK

Garden symphylans feed on the roots of many plants, including field crops, vegetables, and flowers. The damage done by these animals is not easy to recognize because it is in the soil and may be similar to that caused by some other root-feeding pests. Poor fertility, lack of rain, bad seed, low mineral content, and insecticide failure are all typical comments from farmers with a symphylan problem. Normally, the symphylan begins to feed on corn as soon as it germinates, and the feeding continues throughout the season. The plants wilt and die under heavy infestations or are stunted so severely that they never shoot an ear. When a plant dies, the symphylans begin to move down the row, killing the plants as they feed. Large areas of a field may be completely killed out. A typically infested field may have areas of good corn, areas of no living plants, and all stages in between.

CONTROL POSSIBILITIES

You can control the garden symphylan with only a few chemicals at high rates, but our experience in Illinois has been very limited. Dyfonate has given good control at Garden Plain and Shannon, Illinois. The granules were broadcast at 2 pounds of active material and disced-in just before planting at Garden Plain. Diazinon at 10 pounds of active material per acre was also used, but complete control was not achieved. Plots with Di-Syston had no better control than the check plots. At Shannon, Illinois (a rootworm-demonstration test), Dyfonate was applied at 1 pound of active ingredient per acre in a band over the row. Symphylan counts were made; no symphylans were found in the Dyfonate plots. All of the other plots had symphylans present.

On the basis of our limited information, Dyfonate appears to be a good chemical to control garden symphylans. For heavy populations, broadcast 2 pounds of active ingredient per acre and disc-in before planting. The 1 pound of active ingredient per acre may be satisfactory for light populations or for emergency basal cultivator treatments.

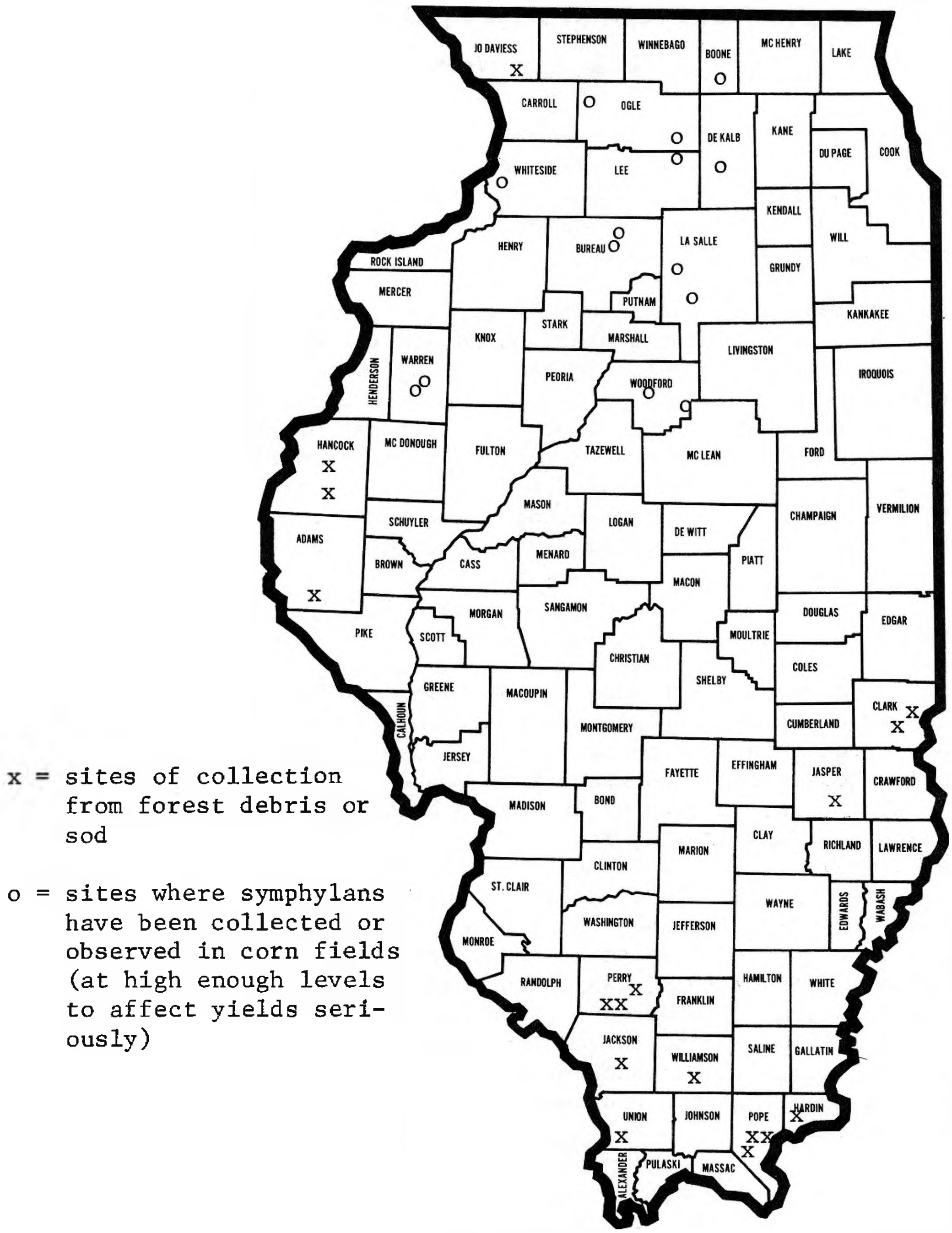

Figure 1. Locations in Illinois where the garden symphylan has been seen or collected.

SOYBEAN WEED CONTROL IN THE MID-SOUTH

R.E. FRANS

Soybeans now constitute an extremely important agricultural crop in the Mid-South area of the United States, one with rich and productive soils, adequate rainfall, and a relatively long growing season. While such conditions are favorable for the growth of agricultural crops, they are also conducive to the growth of a major agricultural pest--weeds.

With such favorable environmental conditions, good weed control becomes an absolute necessity in crop production. Soybeans are planted about mid-May or somewhat later, up until the first of June, which is also the optimum time for the rapid germination and establishment of weeds. Too often in the past, soybeans were treated as a secondary crop, with either rice or cotton capturing the major attention of the producer. In this secondary status, soybeans have often suffered from competition because weeds became established before much attention was given to timely cultivation. Consequently, the input of management practices has always been low, although the adoption of herbicide practices has increased in recent years.

PREEMERGENCE METHODS

Early herbicide practices used in soybeans in the Mid-South bear the unmistakable mark of the chemical weed control practiced for cotton. Farmers adopted herbicides early for the cotton crop because of its high cash-income value and because cotton had to be protected against the weeds that could not be controlled only by cultural methods. Unfortunately, many of the early herbicides available for the soybean crop were lacking in selectivity for the crop, and often gave inadequate control. We have tested and used a whole range of herbicides known or commercially used for soybeans, including Alanap; Pentachlorophenol; Amiben; Randox; Lorox; and the more recent ones--Planavin, Treflan, and Vernam. In certain cases, some of these herbicides either were not accepted or could not be used in our area for various reasons. Randox, for example, was often ineffective on our low-organic-matter soils. Alanap and pentachlorophenol often caused injury when planting was followed by high rainfall, and are no longer recommended as single herbicides. Much the same situation exists with the other herbicides just mentioned. Our experience with them indicated that the problems involved often limited their adoption by our soybean producers.

Dinoseb mixtures

Much of our early work with mixtures in Arkansas was directed toward alleviating both variability in control and the crop damage often caused by using some of the materials just mentioned. As a matter of course, some of these mixtures involved the use of "dinitro" or DNBP, more recently assigned the common name, dinoseb. Some of our earliest work with mixtures involving dinoseb included preemergence applications just as the crop was being planted. It soom became evident, however, that the inherent contact activity of dinoseb made it profitable to delay application until the soybeans were just emerging from the soil, at a time when weeds were also just beginning to emerge. This development aided considerably in the efficiency of some of these early mixtures with dinoseb, leading to the present "cracking-stage" applications that have been of interest in recent years. It was our experience in Arkansas that delayed applications of mixtures of dinoseb with such herbicides as Amiben, Lorox, CIPC, or diphenamid resulted in much more-effective weed control than when applications were made at the time soybeans were planted. Too often, however, lack of timely applications resulted in extreme crop damage.

This drawback has been overcome to a certain extent as the airplane has become more important in herbicide spraying. Large acreages now can be covered quickly while soybeans are in the proper stage of growth. Adoption of the cracking-stage method on control has not been widespread. It may be that the introduction of newer and more-selective soybean materials will capture the imagination of the southern soybean producer far more than the cracking-stage methods. Some, however, believe that there is a place for this method, since certain "resistant" broad-leaved weeds can be controlled easily just as they are emerging.

POSTEMERGENCE METHODS

Early postemergence practices for soybeans also reflected the practices in common use for cotton. Previously, the most-common postemergence methods used for the cotton crop were postdirected, herbicidal oil-and-flame cultivation. Early attempts to adapt herbicidal oil to soybeans were promising. We did find that soybeans were not quite as tolerant as cotton to herbicidal oil, and we had to limit the number of applications to not over two, and the quantity to not over five gallons per acre on the band. We also found that flame cultivation could be initiated once herbicidal oiling was completed, and that this could effectively extend the period of weed control until soybeans had begun to shade the soil. Yet, it must be admitted that both herbicidal oil and flame cultivation require precise equipment, a thorough-going knowledge of calibration, and close attention to the weed situation in the crop. These two practices are not used as widely now as they once were.

Chloroxuron

Newer developments for postemergence control in soybeans have included such herbicides as the substituted ureas. One that has been of interest to farmers in the Mid-South is chloroxuron, or Tenoran. It does have its limitations, and these must be recognized if the compound is to be used successfully. It is most active on small, broadleaved weeds, probably not over 2 to 3 inches in height. By contrast, it is notably weak on grass weeds and probably will give little control on any of them that are over an inch high. Although chloroxuron is cleared for use over the top of the soybean crop, we find that it is considerably damaging when used in this manner; we think that it should be limited to directed applications. We have begun work on oil-emulsion mixtures with chloroxuron this past year, and these show considerable promise from the standpoint of increasing control of some of the more-resistant broadleaved weeds.

Dinoseb

About the time the ureas became of interest to our soybean farmers, we saw a renewal of interest in dinoseb, but this time as a directed, postemergence application on soybeans for certain, hard-to-kill, broad-leaved weeds. Fair control of common morning glory could be obtained with a couple of well-timed applications. For the most part, these applications had to be made early, or before the morning glory plant had grown very much. Early results were not always encouraging, since applications were often initiated on soybeans not over 3 inches tall. In succeeding years, applications were delayed until soybeans were 5 to 6 inches tall, at which time the crop was found to be less susceptible to injury. It was soon determined that soybeans could tolerate rates ranging from 1-1/2 to 3 pounds per acre, depending on the temperature at the time of application. Interest in this particular practice has mushroomed over the past two growing seasons, in spite of the fact that postdirected applications have not received full approval or clearance. In spite of this, farmers have applied it wholesale to large soybean acreages in the Delta. It does have a bright future, provided that complete clearance can be obtained. Present indications are that the material will not be registered for postdirected use until early 1970.

2,4-DB

It may be of interest to note that another old herbicide, 2,4-DB, is now coming to the forefront as a possibility for postdirected control in soybeans. This compound has been used extensively in the Mid-South as a salvage chemical where cocklebur has become a major infestation. Most commonly, it is sprayed over the top of soybeans just beginning to bloom. This is a salvage operation, because the soybean crop often is injured by such applications to the point that yields may be reduced. However, any yield reduction from the herbicide is far outweighed by the competition from cocklebur if this weed is allowed to remain uncontrolled in soybean fields. Last year, new work was undertaken with postdirected applications of 2,4-DB at an earlier growth stage. Soybeans were found to be much more tolerant when the material was applied in this manner than when applied over the top. Furthermore, the weeds that could be controlled by 2,4-DB were just as susceptible at the earlier growth stages as they were at the later ones. Consequently, if we can obtain the differential in height between the soybean and susceptible weeds (such as cocklebur or morning glory), we feel that postdirected applications of 2,4-DB will also enjoy a very bright future with soybean growers in the South.

SUMMARY COMMENTS

The adoption of herbicides by the Mid-South soybean grower, although slower than that experienced with the cotton crop, has been steady over the years. The producer will undoubtedly continue to look at an integrated program of herbicide practices designed to protect his soybean crop at its critical growth stage, namely as it is germinating and becoming established. A sound program of both preemergence and early postemergence practices will continue to be of considerable assistance to our farmers in the years ahead.

EFFECTS OF 2,4-D, DICAMBA, AND PICLORAM ON SOYBEAN YIELDS[1/]

L.M. WAX

Soybeans are grown in rotation with corn in Illinois. They are also grown next to other crops and next to pastures, highways, power lines, and railway rights-of-way. Weed-control practices often demand the use of (2,4-dichlorophenoxy) acetic acid (2,4-D) or related compounds. The drift of herbicide spray particles and vapor occasionally damages soybeans in adjacent fields.

2,4-D

Although 2,4-D has been used to control certain weeds in soybeans, chlorophenoxy herbicides at the rate of 1/8 pound per acre or more have usually damaged soybeans and reduced yields. Earlier studies in Illinois showed that 2,4-D reduced soybean yields least when it was applied at an early stage of growth.

DICAMBA AND PICLORAM

Two relatively new herbicides--3,6-dichloro-o-anisic acid (dicamba) and 4-amino-3, 5,6-trichloropicolinic acid (picloram)--control some weeds better than 2,4-D. However, these compounds appear to have a much greater potential for damage to nearby soybean fields by spray or vapor drift than does 2,4-D. Apparently, picloram, and to a lesser degree, dicamba, persist in the soil for considerably longer than 2,4-D, and would likely present a far-greater potential residue hazard to soybeans grown in rotation with crops or pastures in which these compounds had been used.

Agronomy South Farm studies

We conducted field experiments over a two-year period at the Agronomy South Farm to determine the response of Harosoy 63 soybeans to soil and foliar applications of dicamba and picloram (as compared with 2,4-D), in an attempt to assess the potential yield reduction from drift and soil residue.

In studies designed to compare these compounds as soil-applied treatments, we used 2,4-D (1, 2, 4, and 8 ounces per acre), dicamba (1/4, 1/2, 1, 2, and 4 ounces per acre), and picloram (1/16, 1/8, 1/4, 1/2, 1, and 2 ounces per acre), incorporating them into the soil with a disk just before planting soybeans. All three chemicals retarded soybean growth and development early in the season. Soybean leaves were generally smaller as a result of 2,4-D treatments; dicamba and picloram caused smaller plants, as well as cupped and crinkled leaves. All three herbicides

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1/ This is a report on the current status of research on weed-control practices. It does not contain weed-control recommendations, nor does it imply that the herbicide uses discussed have been registered. All uses of pesticides must be registered by appropriate state and federal agencies before their recommendation and use.

increased branching. Soybeans grown in soil treated with 2,4-D seemed to escape its influence about mid-season. But dicamba, and particularly picloram, influenced soybean growth and development for a longer period. Compared with the untreated control plots (about 40 bushels per acre), 8 ounces per acre of 2,4-D or 4 ounces per acre of dicamba had little effect on seed yields in the test plots. In contrast, picloram reduced yields about 40 percent at 1/2 ounce per acre and about 95 percent at 2 ounces per acre. Soybeans grown on these plots the next year after treatment had malformed leaves throughout the season, where 1/2,1, or 2 ounces per acre of picloram had been used the previous year. However, yields were not reduced below the level of the untreated control plots. Soybeans planted in plots treated with 2,4-D or dicamba in the previous year did not show any evidence of injury.

To compare the response of soybeans to foliar applications of these compounds, we sprayed 2,4-D (1/4, 1/2, 1, and 2 ounces per acre), dicamba (1/32, 1/16, 1/8, 1/4, 1/2, and 1 ounce per acre), and picloram (1/64, 1/32, 1/16, 1/8, 1/4, and 1/2 ounce per acre) over the top of soybeans at two stages of growth: (1) prebloom, third trifoliolate, about 3 weeks after planting; and (2) bloom, eighth trifoliolate, about 6 weeks after planting.

All rates of 2,4-D tested caused curving and twisting of petioles and stems, followed by strapping and puffing of the newly formed leaves. Similarly, all rates of dicamba and picloram in these studies caused some petiole and stem curvature, but newly formed leaves were cupped and crinkled.

The highest rates of dicamba and picloram stunted and killed apical buds. Often, especially when treated at the prebloom stage, plants with damaged apical buds produced a substantial number of branches. Foliar treatments of 2,4-D up to 2 ounces per acre had little effect on soybean yields when applied at the prebloom stage; only slightly reduced yields, when applied in the bloom stage. Prebloom applications of dicamba and picloram at 1/2 ounce per acre reduced soybean yields about 20 and 40 percent, respectively. Treatements at the same rate (1/2 ounce per acre) in the bloom stage were considerably more injurious to soybeans. Dicamba reduced yields 50 percent and picloram reduced yields 95 percent.

SUMMARY

In these studies, soybean injury from picloram exceeded that from equivalent rates of dicamba; the injury to soybeans from dicamba exceeded that from 2,4-D. The rates of dicamba and picloram that reduced yields when applied at the bloom stage and the lowest rate of picloram that reduced yields as a soil treatment probably lie within the range of rates that sometimes drift from treated areas near soybean fields.

SOIL INCORPORATION OF PESTICIDES

B.J. BUTLER

Let us look briefly now at the job of incorporation we can expect from various mechanisms and tools, as well as consider a few related aspects of the process.

GENERAL INCORPORATING ABILITY OF FIELD EQUIPMENT

Naturally, the soil-moving action of any tool affects its incorporating ability. Tools such as row-crop and field cultivators, chisel plows, and spring-tooth harrows primarily shatter and lift the soil. Hence, there may be some settling of fines downward and movement of clods upward, but very little mixing occurs. Primary tillage tools that invert the soil either partially or completely, such as moldboard plows, disk plows, and some middlebusters, will tend to move surface-applied materials either completely to the depth of tillage or to a varied depth along a diagonal plane, depending on the amount of soil inversion. The rotary hoe can do a fair job of shallow incorporation with proper tine design, operating speed, and soil conditions. All too frequently, however, they leave a great deal of the chemical on the surface. Classes of tools that do more mixing, powered rotary tillers, tandem disk harrows and the like, will do a better job of incorporation than any of the other tools mentioned.

Having looked at length at both powered rotary tillers and tandem disk harrows as incorporating tools, we can make a few conclusions.

ROTARY TILLERS

With rotary tillers, both the vertical and horizontal distribution of granules can be improved by keeping the increment of cut under 2 inches, by using more knives, higher rotor speeds, or slower ground speeds. The higher rotor speeds, however, will require a greater increase in horsepower than the other two methods of lowering the increment of cut.

L-shaped blades incorporate better than knife blades. With L-shaped blades, the depth of incorporation in relation to the tillage depth can be varied by changing the rake angle. (The rake angle is the angle between the long axis of the blade cross-section and a tangent to the circle circumscribed by the tip, with a lagging angle being one with the heel of the blade inside the tip circle and a leading angle being the opposite.) Lagging blade angles cause the blade to "bite" into the soil, moving it back and towards the center; leading blade angles cause the soil to be "crowded" outward.

Lagging blade angles are better than leading ones. Small lagging angles such as 15 to 20 degrees will tend to produce shallow incorporation--up to 30 to 40 percent of the depth of tillage. Large lagging angles such as 45 to 60 degrees tend to incorporate throughout the depth of tillage.

Because of the intensity of mixing, there is little difference in the incorporation of spray versus granules when a rotary tiller is properly used.

TANDEM DISK HARROWS

Although widely used, the tandem disk harrow is not a good tool for incorporation. It has a tendency to partially invert a soil slice and to concentrate the pesticide along a diagonal plane of varying depth parallel to the direction of travel. Hence, with one disking, the result is zones of high concentration, rather than even distribution. An additional cross-disking will create spots of high concentration. An additional disking in the same direction is as good as or better than cross-disking. A second disking, regardless of direction, does not increase the uniformity of incorporation very much.

RELATED COMMENTS

Studies of the effects of travel speed and gang angle have shown that both vertical and horizontal distribution can be improved by increased speeds and blade angles. In other words, use high but safe speeds, and keep the gangs angled at the maximum angle permitted by the disk design.

For disk incorporation, the soil should be loose and not too moist to achieve best results. Granules should not be applied to a moist soil surface. They will stick to the clods, which tend to remain on or move to the surface. For the same reason, granules will incorporate better than sprays, especially under cloddy conditions. A wet, sticky soil layer under the soil surface resists incorporation quite successfully.

SUMMARY

A disk harrow can do a satisfactory job of incorporation if the points previously given are considered and if the chemical can do its job with a fairly wide range in soil concentrations. A powered rotary tiller can do a better job of incorporation than the disk harrow, but proper adjustment and operation are critical to best results.

SOYBEAN WEED CONTROL

M.D. McGLAMERY

You are often asked to prescribe control treatments for soybean weeds. There is no panacea or cure-all. Treatments must fit individual situations and problems.

BASIC APPROACH

Most cultivation operations are for weed control. Chemical herbicides may replace some of these operations, but a combination of cultivation and herbicides will probably provide a more-consistent and complete weed control program.

Rotary hoeing is fast and very effective, if properly done; but it is often performed too late for maximum weed control. Successful row cultivation requires operator skill, timeliness, and correct adjustment. This operation is often more successful and faster when an effective herbicide has been applied over the row.

TECHNIQUES

You must select the herbicide that will control your customer's major weeds. Herbicides vary in their "control spectrum." Herbicide labels provide some information about the weeds they will control, but give little if any information about those not controlled. A weed-selectivity chart is given in Table 1. These ratings are approximate, and are for average conditions.

You must determine the character of the soil where the problem occurs. The organic matter and clay content of the soil influence herbicide performance and usage. We suggest using the *Color Chart for Estimating Organic Matter in Mineral Soils of Illinois*, AG-1941, where more definite information is not available. Guidelines for estimating Lorox, Planavin, and Treflan rates are provided in Table 2. Lorox and Planavin will be sold in Illinois primarily for soils of less than 3-percent organic matter.

Amiben, Lasso, and Vernam rates are usually given as a range, with the higher rate being recommended on soils having high clay and organic-matter content. Ramrod and Randox perform best on soils with a medium to high amount of organic matter.

Many of the soybean herbicides can occasionally cause injury because of the narrow margin of selectivity (crop tolerance) between crop injury and weed control. Soybeans have the ability to outgrow some injury without reducing yield. Crop tolerance ratings are given for the common soybean herbicides in Table 3.

The length of weed control needed will depend on row width, planting date, and soybean variety. Approximate persistence ratings are given in Table 3. If persistence is too long, susceptible crops may be injured the following year. There were some reports of Treflan carryover injury to corn in 1968. This has been attributed primarily to misapplication and to improper incorporation and seedbed preparation.

Table 1. Soybean Herbicide Weed-Selectivity Chart

	Preemergence or preplant									Post-emergence	
	Alanap Plus	Amiben	Lorox	Lasso	Planavin	Ramrod	Randox	Treflan	Vernam	2,4-DB	Tenoran
Grass weeds											
Barnyard grass	2	1	2	1	1	2	2	1	1	4	3
Crabgrass	2	1	1	1	1	1	1	1	1	4	3
Foxtail grasses	2	1	2	1	1	1	1	1	1	4	3
Johnsongrass seedlings	3	2	3	3	1	4	4	1	2	4	3
Wild cane	3	2	3	3	1	4	4	1	1	4	3
Yellow nutgrass	4	4	3	2	4	3	4	4	2	3	2
Broad-leaved weeds											
Cocklebur	3	3	3	3	3	3	4	3	3	1	2
Jimsonweed	3	2	2	4	3	4	4	3	3	3	2
Lamb's-quarter	2	1	1	2	1	2	3	1	2	2	2
Morning glory	3	3	2	4	3	4	4	3	2	2	2
Pigweed	2	1	1	1	1	1	2	1	2	2	1
Ragweed	2	1	1	3	3	3	3	3	2	2	2
Smartweed	1	2	2	3	2	3	4	2	3	2	3
Velvetleaf	3	2	2	3	3	3	4	3	3	3	3

1 = good control; 2 = fair control; 3 = poor control; and 4 = no control.

Table 2. Soybean Herbicide Rates for Illinois Soils

	Commercial formulation per acre on a broadcast basis			
		Planavin		Treflan
Organic matter	Lorox 50W	75W	4 lb./gal.	4 lb./gal.
(percent)	(pounds)	(pounds)	(pints)	(pints)
1	1	1	1-1/2	1
2	2	1-1/2	1-1/2 to 2	1 to 1-1/2
3	3	2	2 to 3	1 1/2
4	4	a/	a/	1 1/2 to 2
5	a/	a/	a/	2

a/ Generally not suggested for these soils because of erratic performance, rate limitations, and crop tolerance.

Table 3. Crop Tolerance Ratings of the Common Soybean Herbicides

Herbicide	Crop tolerance	Length of control (weeks)
Alanap Plus	Fair	4 to 6
Amiben	Fair+	6 to 8
2,4-DB	Fair	1 to 2

(continued)

Table 3. Crop Tolerance Ratings of the Common Soybean Herbicide (Cont.)

Herbicide	Crop tolerance	Length of control (weeks)
Lorox	Fair	5 to 7
Lasso	Good	6 to 8
Planavin	Fair+	8 to 10
Ramrod	Good	4 to 6
Randox	Good	3 to 5
Tenoran	Fair	0 to 2
Treflan	Fair+	8 to 12
Vernam	Fair	6 to 8

Table 4. Application Rate of Soybean Herbicides

Trade name	Broadcast rate: Active ingredient (lb./A.)	Broadcast rate: Liquid (lb./A.)	Granules (lb./A.)
Preemergence			
Alanap Plus	5 (3 + 2)	6 qt.	40 lb.
Amiben	2 to 3	4 to 6 qt.	20 to 30 lb.
Lasso	1 1/2 to 2 1/2	1 1/2 to 2 1/2 qt.	15 to 25 lb.
Lorox	1 to 2	2 to 4 lb.	
Planavin	.75 to 1.50	1 to 2 qt.	
Ramrod	4	6 lb.	20 lb.
Randox	4	4 qt.	20 lb.
Treflan	0.5 to 1.0	1/2 to 1 qt.	10 to 20 lb.
Vernam	2 to 3	1 1/2 to 2 qt.	20 to 30 lb.
Postemergence			
2,4-DB	.2	1/2 qt.	
Tenoran	1 to 1 1/2	2 to 3 lb.	

You must determine when and how the farmer wants to treat his soybeans. Some herbicides are applied preplant, which requires broadcast application. Other herbicides are applied preemergence, but are not available as granules; these must be applied as liquids.

MAJOR HERBICIDES

A brief description of the major herbicides for soybeans follows. For further information, see the *1969 Weed Control Guide*, which is included at the back of this manual.

Preplant herbicides

Treflan (trifluralin) is one of the most-effective and consistent herbicides for control of grass seedlings, including wild cane and Johnsongrass. Treflan can be applied up to 6 weeks before planting, but incorporation should follow soon after application.

Planavin (nitralin) is similar to Treflan in terms of the weeds it will control, but slightly higher rates will be needed for equivalent control. Planavin will be sold primarily in southern Illinois below highway 40.

Vernam (vernolate) may be applied preplant or preemergence. Light incorporation usually improves performance. Occasionally, soybean emergence is delayed.

Preemergence herbicides

Alanap Plus (NPA + CIPC) has replaced most of the regular Alanap. Weed control and crop injury have been erratic.

Amiben (amiben) is one of the most-popular herbicides for soybeans. It occasionally causes soybean stunting and malformed roots.

Dacthal (DCPA) is used primarily for annual grass control. It is cleared for soybeans and the crop tolerance is good, but the weed control has been erratic. Dacthal has been used primarily on vegetable crops. Slight incorporation often increases performance. It is not available as a granule.

Lasso (CP-50144) is a new and promising herbicide. We hope registration will be made before soybean planting. Lasso is similar to Ramrod in the weeds it will control. It has less irritation and longer persistence, and it will perform better than Ramrod on lighter soils.

Lorox (linuron) is most effective on the lighter, low-organic-matter soils. Rates must be adjusted accurately for soil type, because selectivity margin is narrow. Lorox will be sold primarily for use on soils of less than 3-percent organic matter. Granules are not available.

Ramrod has been an effective herbicide for grass control, but it is presently restricted to use on soybeans grown and used for seed.

Randox (CDAA) is primarily for the control of annual grasses on relatively dark soils. Soybeans have good tolerance to Randox. Skin irritation and short persistence have been its big disadvantages.

Postemergence herbicides

Tenoran (chloroxuron) should be applied when broad-leaved weeds are less than 1 to 2 inches high. The use of a surfactant in the spray will enhance control. At present, it is restricted to use before 120 days ahead of harvest. This restriction will probably be changed to 90 days in 1969.

Butyrac or Butoxone (2,4-DB) can be applied from 10 days prior to bloom to mid-bloom. This herbicide is used mostly for control of serious infestations of cocklebur. Serious crop injury can result if application rates are not accurate.

RATE INFORMATION

Rate expressions have often been confusing, depending on whether they are expressed in terms of the active ingredient or formulated product and whether they are expressed on the basis of a broadcast or band application. Table 4 gives rate information on a broadcast basis for both the active ingredient and formulated product. Band application will require proportionately less, depending on the row and band width.

CLOSING COMMENTS

You can operate a "self-service drugstore" where the farmer chooses his chemicals without consultation, or you can operate a "plant-protection clinic" where the farmer comes to you for consultation and services. This will depend on your ability to keep up-to-date on herbicide information.

REVIEW OF CORN BORER CONTROL

W.H. LUCKMANN

The European corn borer will probably be a very important pest in field and sweet corn during 1969. The overwintering population in several areas equals our high populations of the early 1950's, and growers should definitely be alerted to the possibility of damage by this pest. A number of steps can be taken to reduce damage from corn borers: (1) use tolerant corn hybrids, (2) avoid unusually early or late planting, (3) destroy overwintering larvae, and (4) use insecticides and apply them at the proper time.

TIMING INSECTICIDE APPLICATIONS

Numerous methods for timing the application of insecticides have been suggested and are now being used. Many of these methods are difficult; in the hands of less-experienced persons, also inaccurate. Illinois has developed and carefully studied a simple and exceedingly accurate technique for properly timing insecticide treatments, one based on the maturity of the corn plant. This criterion is known as the "tassel-ratio index."

THE TASSEL-RATIO INDEX

The tassel-ratio index involves comparing the relationship between the height of the tassel and the height of the plant, designating the maturity of the plant as a number ranging from 1 to 100. The measurements used in the tassel-ratio index and the formula for computing maturity are illustrated in Figure 1.

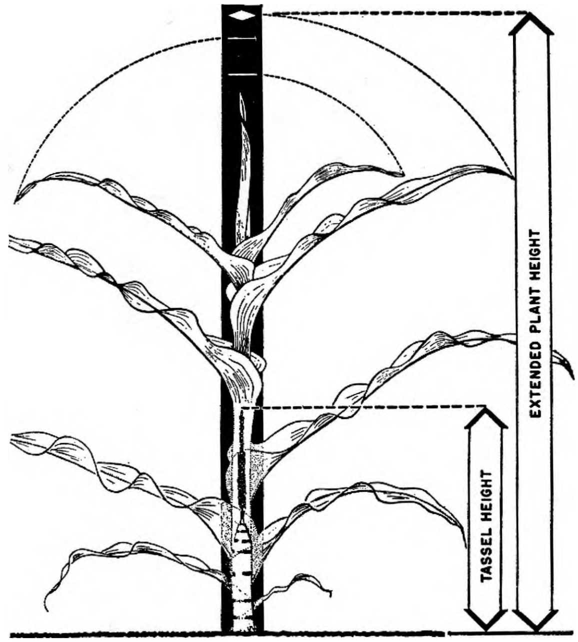
As an example, suppose that the extended height of the corn plant is 50 inches and the distance from the base of the plant to the tip of the tassel is 15 inches. The plant would then have a tassel ratio of 30.

Example: $$\frac{\text{Height of the tassel}}{\text{Height of the plant}} \quad \frac{15 \text{ inches}}{50 \text{ inches}} = .3 \times 100 = 30$$

Corn borers do not survive well on corn with a tassel ratio of less than 20. If a field of corn has a tassel ratio of 30 or over, the field is very susceptible to borer attack, and a large percentage of larvae hatching from egg masses will survive.

TREATMENT

Field corn needs to be treated only once for the first-generation corn borer, if the application is properly timed. Apply the insecticide at some time between tassel ratio 40 and 60. Depending on the variety and soil fertility, tassels begin to emerge in field corn at a tassel ratio of 65 to 75. Surveys, conducted throughout central and northern Illinois for a number of years, show that about 10 to 15 percent of the total corn acreage normally reaches this critical period of growth during the moth flight of the first generation.



Broken line (*top*) shows height of plant when longest leaf is pulled upward. To get plant height, measure from base of stalk to tip of longest leaf when pulled upward. Broken line (*bottom*) shows tassel height. To get this height, slit the stalk lengthwise and measure as shown.

Figure 1. $100 \frac{(TH)}{(PH)} = Tr$, *where TH represents distance from base of plant to tip of tassel bud, PH represents distance from base of plant to tip of longest leaf extended, and Tr is the tassel-ratio index.*

Recent reports[1/] from the USDA Corn Borer Laboratory in Iowa show that a number of insecticides give good control of the European corn borer. Chemicals producing control equal to that obtained with 1 pound of DDT per acre are:[2/] phorate (1), diazinon (1), Dursban (0.25), Furadan (0.25), EPN (0.25), Azodrin (0.50), Gardona (0.75), dyfonate (0.75), and parathion (0.5). The insecticides and dosages listed above are the result of research, and some of the insecticides *are not labeled* for use on corn.

Illinois recommends that growers use either spray or granule applications of carbaryl, 1.5 pounds; diazinon, 1 pound; or parathion, 0.5 pound per acre for controlling corn borers in field and sweet corn.

1/ Harding, J.A., W.G. Lovely, and R.C. Dyar. Field Tests of Chemicals for Control of the European Corn Borer. J. Econ. Entomol. 61(5): 1427-1430. 1968.

2/ Pounds per acre are shown in parentheses.

WEED-CONTROL PROGRAMS FOR CORN

E.L. KNAKE

You now have considerable flexibility in the time and method of herbicide application, and you have a variety of products from which to choose to help solve specific weed problems under specific conditions. Programs can be designed to fit individual preferences for type of formulation and cost.

PREPLANT APPLICATIONS

These are increasing in popularity. It is one way to help distribute the work load, an especially important consideration on large acreages.

Atrazine. This can be applied within two weeks before planting, usually the closer to planting the better. Either surface application or shallow incorporation can be used. Incorporation is not essential but may be helpful during a relatively dry period or can help control any weeds present just before planting.

Sutan. Application of this agent should be made before planting and should be incorporated. The greatest interest is in the *Sutan-atrazine* combination for a preplant, incorporated treatment. The addition of Sutan can improve control of annual grasses, and even the reduced rate of atrazine can control many broad-leaved weeds. Corn tolerance with the Sutan-atrazine combination appears to be satisfactory. However, trial use is suggested for 1969.

Many custom applicators and growers like a preplant broadcast application of herbicide with non-pressure liquid fertilizer. This practice is continuing in many areas, in spite of the cost advantage for anhydrous ammonia.

The time of application will be dictated somewhat by the weather. The high percentage of fall plowing completed in 1968 should allow more time for preplant herbicides this spring. But if the weather does not permit application before planting, be prepared to switch to an alternate program.

PLANTING-TIME APPLICATIONS

Application at planting. Especially for the smaller farmers who have time for herbicides at planting and for good cultivation, band-applied herbicides, applied at planting time, will provide an economical and practical approach, reducing the herbicide cost.

Atrazine. This is still the leader on the light-colored, low-organic-matter soils where growers are not opposed to spraying. An increasing amount of atrazine is being broadcast either at planting time or shortly thereafter. The low rates required for the lighter soils make this an economical treatment. Increasing attention should be given to the panicum problem.

Ramrod. It is popular on the darker soils where annual grass weeds are a major problem and where granular, band-applied applications are desired.

Ramrod plus atrazine. This combination looks good for surface application at planting time or very soon thereafter. Broader-spectrum weed control can be achieved under a wider variety of soil and weather conditions, while also reducing the possibility of herbicide residue affecting subsequent crops. Ramrod is quite effective on annual grass weeds; even the reduced rate of atrazine can control many broad-leaved weeds, such as smartweed and pigweed. However, where velvet leaf is a problem, the reduced rate of atrazine may not be adequate. This combination will likely be available as a prepackaged combination in 1969, or the products may be "tank-mixed." You will have to spray if you use this combination in 1969.

Knoxweed. Although somewhat erratic, this chemical has found a place with granular-band surface application where control of both broad-leaved and annual grass weeds is desired. Liquid formulation is also available.

Other. A variety of other herbicides are available for planting-time application: 2,4-D ester; Randox; Randox-T; and two fairly recent introductions--Londax and Primaze. Although label clearance is anticipated for Lasso for both corn and soybeans in 1969, the major promotion will be for use on soybeans.

POSTEMERGENCE APPLICATIONS

The use of 2,4-D in this way is still one of the most effective and economical treatments for controlling broad-leaved weeds. A good grass killer, such as Ramrod, followed by postemergence 2,4-D provides a good program.

Although there was more than the usual amount of corn injury from 2,4-D in 1968, the popularity of 2,4-D is likely to continue. However, where applicators and growers desire control of broad-leaved weeds with less risk of corn injury, a reduced rate of atrazine applied preemergence can be considered.

Banvel. This agent has had limited acceptance for postemergence weed control in corn because of the amount of injury to nearby soybeans.

Atrazine and oil. Its performance did not appear to be as good in 1968 as it was in 1967. Some problems occurred with injury directly to corn, as well as with injury to soybeans where atrazine and oil had been applied the previous year.

Other. Directed sprays with Dowpon or Lorox may be helpful for some situations, but these have not been popular.

IN SUMMARY

Preemergence applications at planting time or very shortly thereafter are usually preferred. However, preplant applications are rated a very close second. These two methods can be interchanged, depending on the time available and weather conditions. Postemergence applications of 2,4-D still deserve strong consideration, but a reduced rate of atrazine applied preemergence, alone or in combinations, may deserve increased attention for controlling broad-leaved weeds.

WEED CONTROL IN THE VEGETABLE GARDEN

H.J. HOPEN

There are three general methods of weed control that can be used in the home garden:

CULTIVATION AND MECHANICAL REMOVAL

This method is the one most used, and it is the safest one in the home garden. Mechanical removal must be repeated several times throughout the growing season of a crop. Vacations or absence from the garden area is a negative factor for this method. Depending on the size of the garden, weed control can be accomplished by power equipment or by wheel and hand hoes.

MULCHING,OR SMOTHERING WEEDS

Basically, this is a method of preventing light from reaching the weed seedling. Any number of opaque materials can be used for mulching: Kraft papers, black polyethylene, ground corn cobs, weed-seed free straw, and other fresh vegetation and composted vegetation.

Additional factors in favor of mulching are: moisture conservation, stabilized soil temperatures, and keeping the above-ground, edible plant portions clean.

USE OF HERBICIDES

This method of control is not practical in small vegetable gardens containing several crop species, because different vegetables and weeds vary in their tolerance to herbicides. Ideally (to control weeds in a garden containing several species), several herbicides should be used. Several desirable herbicides for specific species remain in the soil longer than one growing season, and may kill or injure specific species the following year.

Application methods must be carefully controlled when a herbicide is used on small areas. The tendency is to apply additional amounts if the quantity measured out "looks" like it is not enough.

The ideal method to control weeds in vegetable crops is with a herbicide for each vegetable species, as outlined in Circular 907, Herbicide Guide for Commercial Vegetable Growers.

Many people using chemical weed control in their vegetable garden do not have enough of an area to treat to make buying several herbicides worthwhile.

If an individual is unwilling to remove weeds by hand and wants to use a herbicide in the home or commercial garden, dacthal[1/] can be used on the species.

1/ Please remember that dacthal *possibly* is not the most desirable herbicide for a large planting of the individual species. The most desirable herbicides for individual species are listed in Circular 907. Dacthal must be applied to weed-free soil, because it is a weed-seed germination inhibitor. Most effective herbicide action is obtained if rainfall or irrigation is applied 2 to 3 days after application.

Crop	Total pounds* of 2-1/2% granular dacthal per 1,000 sq. ft.	Total pounds* of 5% granular dacthal per 1,000 sq. ft.	When to use
Snap or garden beans (not lima)	8-9	4-4.5	Immediately after seeding
Broccoli	8-9	4-4.5	Immediately after seeding or transplanting
Brussels sprouts	8-9	4-4.5	Immediately after seeding or transplanting
Cabbage	8-9	4-4.5	Immediately after seeding or transplanting
Cantaloupe	8-9	4-4.5	To the soil, 4-6 weeks after seeding**
Cauliflower	8-9	4-4.5	Immediately after seeding or transplanting
Collards	8-9	4-4.5	Immediately after seeding
Cucumbers	8-9	4-4.5	To the soil, 4-6 weeks after seeding**
Eggplant	8-9	4-4.5	Immediately after transplanting, or up to 6 weeks after transplanting**
Lettuce (leaf & head)	8-9	4-4.5	To the soil, 1-3 weeks after emergence**
Onions	8-9	4-4.5	Immediately after seeding
Peppers	8-9	4-4.5	To the soil, 4-6 weeks after transplanting**
Potatoes	8-9	4-4.5	Immediately after planting
Squash	8-9	4-4.5	To the soil, 4-6 weeks after seeding**
Strawberries	8	4	At time of transplanting or to established beds in fall and early spring (Do not apply after first bloom)
Tomatoes	8-9	4-4.5	To the soil, 4-6 weeks after transplanting**
Sweet potatoes	8-9	4-4.5	Immediately after planting
Turnips	8-9	4-4.5	Immediately after seeding
Watermelons	8-9	4-4.5	To the soil, 4-6 weeks after transplanting**

*Seventy-five percent wettable powder dacthal can also be used at the *total rate* of 14 pounds per acre for all except strawberries, on which a total rate of 12 pounds per acre must be used. Five percent and 2-1/2 percent granular dacthal is available in 50-pound bags.

**Must be applied to weed-free soil.

EXTENT OF DAMAGE BY COMMON STALK BORERS

STEPHEN STURGEON

Common stalk borer moths emerge in late August and early September, then mate and deposit eggs on grasses and weeds. The eggs overwinter in these grasses, hatching in May of the following spring. These worms become full-grown during the last of July and the first of August, when they transform to the pupal stage. There is only one generation a year.

FEEDING PATTERN

At first, the newly hatched larvae feed in any stem, but move to larger stemmed plants (such as corn) as the larvae become larger. Their feeding results in stunted, barren, or even dead plants. The worms usually remain within two or three plants and do not migrate through entire fields, as some people believe. Although their damage is severe to individual plants, it is localized to only the first five to ten rows along fences, ditches, grass waterways, and other areas where weed growth was common the previous August.

CONTROL

The only justifiable control is to mow fence rows and grassy areas next to cornfields by mid-August. This will greatly reduce egg-laying.

Research was conducted with this insect in which 100 infested young plants and 100 plants with no infestation were tagged in October, with red and yellow tags, respectively.

Later in October, all ears were taken from the plants, dried, and shelled. The results are summarized in Table 1. To use this information, determine the percent of plants infested, multiply by 37 percent, and you will have the percent of anticipated yield loss. Whether chemical control is justified in the few rows of corn involved can easily be determined. However, considerable damage is done before the infestations are discovered.

Table 1. Loss Caused by the Common Stalk Borer

Treatment	Number of ears	Av. lb. shelled corn	Percent loss
Not infested	200	45.63	..
Infested	200	28.85	37

ALFALFA WEEVIL RESEARCH RESULTS

E.J. ARMBRUST

The alfalfa weevil continues to be our most destructive forage-crop insect pest. Without control, alfalfa cannot be grown in weevil-infested areas.

BACKGROUND ON DEVELOPMENT

The alfalfa weevil was first discovered in the United States in 1904, near Salt Lake City, Utah, where it was probably introduced from Europe. After a study of the climatic limitations of the weevil in Europe, several workers predicted that the distribution of the weevil would be limited to the Rocky Mountain States and those west of the Rockies. Such was the case for nearly fifty years. However, in 1952, the weevil was discovered in Maryland. It spread rapidly north and south. In 1964, it was found for the first time in southern Illinois.

PATTERN OF REPRODUCTION AND GROWTH

During the fall months and on warm days throughout the winter, the females lay clusters of oval-shaped eggs within the alfalfa stem. The eggs darken with age. In warm weather, the eggs hatch in 1 to 2 weeks. In cool weather, egg-hatch is delayed and the eggs accumulate in the fields until temperatures are favorable for hatching. This accumulation of eggs accounts for the sudden increase in the number of larvae and for the almost complete destruction of first-crop alfalfa in a matter of days. For this reason, growers should make frequent checks in all of their fields.

The newly hatched larvae are about 1/20 of an inch long and are yellow in color, except for a black head. They begin their feeding in the growing tip of the alfalfa plant. The tip must be peeled apart in order to see the larvae, because the newly hatched larvae are not usually picked up with a sweep net. Larvae feed for 3 to 4 weeks. When fully grown, they are about 3/8 of an inch long, green in color, and have a white stripe down the middle of their backs. Larval feeding results in extremely heavy damage to the first crop. As soon as the larvae have consumed the growing tips, they begin to feed on the lower foliage, skeletonizing the leaves. Damaged leaves dry rapidly and the field takes on a frosted appearance. In time, there is nothing left but dried stems.

Cutting the alfalfa greatly reduces the number of larvae, but many eggs will be left in the stubble and the regrowth of the second crop may suffer heavy damage if not treated. This is especially true during dry weather when the regrowth is normally slow.

After the larvae finish feeding, they spin delicate net-like cocoons on the plants, within the curl of fallen dead leaves, or in other litter on the ground. The pupal stage lasts for 1 to 2 weeks, after which the new adults emerge, from late May to the middle of June.

The adults are snout beetles about 3/16 of an inch long. They are brown in color and have a broad, dark stripe extending down their backs from the front of their heads over more than half the length of their bodies. As the adults age, they become almost uniform in color. Most of the adults migrate from the alfalfa soon after emergence and remain in a resting stage during the summer in protected wooded areas, fence rows, and ditch banks surrounding the fields. They return to the alfalfa during the fall, mate, and begin egg-laying. It is at this time that fall-seeded alfalfa becomes severely infested. The adults are weak fliers, and during these migratory periods they are carried great distances by the wind.

The first, large number of larvae found during the early spring no doubt come from the eggs laid in the fall, or perhaps from overwintering larvae. In many northeastern states, fall egg-laying is not as extensive as in the southern states. Thus, the larvae hatch over a shorter period of time in the northeast than in the south, where the weevil has a head start on the alfalfa plant. Eggs will also begin to hatch at this time. The early hatching of larvae in southern Illinois leads to a prolonged larval feeding period, making control more difficult than in the southern states because one insecticide application will not outlast this feeding period. Egg-hatch during the late winter and early spring in southern Illinois allows new adults to produce a second generation of larvae and adults during the summer. This second-generation population is very small.

CONTROL PRACTICES

Climatic conditions vary greatly within Illinois, and the biology of the weevil within the state will vary just as much. Because of these differences, control practices in southern Illinois will no doubt be different from those in the northern part of the state.

Many alfalfa producers in the southern counties still find the insect difficult to control. The application of insecticides to alfalfa is a relatively new practice, and they lack experience in the proper timing of sprays and the proper use of equipment. Those who have controlled the weevil properly have been able to produce more and better alfalfa than in past years. Along with weevil control, they are controlling many other insects that have been taking their share of the crop. It is still possible to grow and maintain alfalfa in spite of the alfalfa weevil, but this is only accomplished through an extensive control program.

This year was unusual in that damage from the alfalfa weevil was not as severe as in past years and the peak of the larval population was delayed several weeks. In certain areas of the state, much benefit was obtained from parasites and especially *Bathyplectes curculionis*. The effect of these parasites on the alfalfa weevil and the relationship of intessive control programs both in the fall and the spring will be discussed.

Of the experimental treatments tested, we can only list Furadan, Supracide, and in some cases Dursban as giving control equal to or better than methyl parathion. Fall insecticide applications showed that under the last year's season conditions made it possible to eliminate at least the first spring insecticide application on the first-crop alfalfa. Best results were obtained with methyl parathion and a mixture of methyl parathion and methoxychlor. Methoxychlor alone and ethyl parathion were failures.

A REPORT ON NEW FUNGICIDES

MALCOLM C. SHURTLEFF

Several relatively new organic fungicides are, or soon will be, replacing older products such as captan, zineb, maneb, sulfur, and fixed coppers for controlling plant diseases. A number of these newer products are systemic and are taken up by plant roots or the leaves to give long-lasting protection.

The best of these new fungicides appear to be:

1. *Benlate* (DuPont 1991) A new, broad-spectrum foliar, seed, and soil fungicide that possesses excellent residual, curative, and systemic qualities--plus ovacidal action to mites. Benlate controls such turf diseases as dollar spot, brown patch, powdery mildew, and possibly smuts, certain rusts, copper spot, red thread, and Fusarium blight. It appears promising for controlling the scab of apple and pear, stone fruits, and pecan; brown rot, Coryneum blight, black knot, and the Taphrina diseases of stone fruits; fruit rots in general; a wide range of leaf spots, blights, and anthracnoses of field crops, fruits, vegetables, and ornamentals; the powdery mildews and Botrytis blights of all plants; black spot of roses; petal blights of azaleas and camellias; and such widespread and damaging soil fungi as *Rhizoctonia*, *Verticillium*, and *Fusarium*.

   Foliar applications have provided outstanding disease control at very low rates (2 to 8 ounces per acre) and with 2 to 4 weeks or more between treatments on a wide variety of crop and ornamental plants, with an exceptional degree of safety to humans, animals, and plants alike. DuPont's Surfactant F should be added to Benlate in all foliar sprays.

   Curative disease control has been demonstrated when applications have been delayed for several days after infection has occurred.

   Control of foliar diseases has been obtained with seed, soil, and stem treatments showing systemic activity. The movement of Benlate is upward in plants. Root and stem application has protected the entire plant for periods of weeks or months. As a long-lasting and effective soil fungicide, Benlate should be uniformly mixed with the root zone soil before planting.

   Benlate has not yet been cleared by federal agencies for any agricultural use.

2. *Thiabendazole* (TBZ) This systemic product of Merck & Co., Inc. is closely related to Benlate in chemical structure and in its broad-spectrum activity. It has already proved itself as an accepted drug for the treatment of helminthiasis in animals. TBZ has not been widely tested in the field, but results so far show a spectrum of plant disease control much like that of Benlate. Young plants (seeds, seedlings, and transplants) of certain species are much more sensitive to TBZ toxicity than older plants.

3. *Vitavax* (Uniroyal) This is another systemic fungicide that is of particular interest as a seed treatment for use with small grains to control loose and covered smuts (including bunt of wheat) and seedling diseases in general. Vitavax is also useful on cotton, peanuts, and sorghum seed to control seed decays and a wide range of seedling diseases with special emphasis on *Rhizoctonia*. Vitavax has been successfully combined with standard seed treatment fungicides (e.g., captan), giving considerably increased stands and yields over the regular product alone.

4. *Fore* (Rohm & Haas) This is a new formulation of Dithane M-45 fungicide for protective use on turf and certain ornamentals. This broad-spectrum product provides proven control of most major turfgrass diseases (except powdery mildew and dollar spot) and many major fungal diseases of ornamentals including leaf spots and blights, botrytis blights, rusts, anthracnoses, and the black spot of roses. Fore has a relatively low order of toxicity to humans and plants alike.

5. *Soluble Coppers* (sold as TC-90, Cal Cop 10, and Copoloid) These completely water-soluble fungicides are generally less injurious to copper-sensitive plants (e.g., vine crops) and are more effective against a wider range of leaf spots and blights, downy and powdery mildews, and anthracnoses than the older fixed or neutral copper products or Bordeaux mixture. Soluble coppers also control such bacterial diseases as the angular leaf spot of cucurbits and the bacterial spot of pepper and tomato. Currently, these materials are very useful for control of the leaf diseases of carrot, celery, cucurbits, peanuts, and sugar beets.

6. *Parnon* (Eli Lilly) This new, highly effective liquid fungicide is specific for control of powdery mildews on ornamentals. It is protective in action and nonphytotoxic to plants at levels greatly in excess of the recommended dosage range. Parnon has considerable foliar tenacity and is not readily removed by overhead irrigation or rainfall. In time, Parnon may be cleared for use on food crops.

7. *Chloroneb* [sold as Demosan (DuPont)] This new systemic soil fungicide is available as a wettable powder, dust, or granules for

control of pre- and postemergence seedling diseases of a wide variety of crop and ornamental plants. It is presently registered as a seed overcoat, planter-box, or in-furrow treatment for diseases of cotton seedlings. Eventually, it should prove to be useful as a supplemental seed or in-furrow band treatment for beans, cucurbits, sugar beets, and other dicot crops and various ornamentals where seedling diseases (seed rots, damping-off, root and stem rots, soil rot) are a problem. Chloroneb is relatively nontoxic to humans and animals.

COLOR CHART FOR ESTIMATING THE ORGANIC MATTER IN MINERAL SOILS IN ILLINOIS

J.D. ALEXANDER

A color chart is now available for estimating organic matter content in the mineral soils of Illinois[1/]. It was developed by correlating the Munsell notations for color (hue, value, and chroma) of surface-cultivated soils of Illinois with the organic-matter content as determined in the laboratory. A multiple correlation coefficient of 0.77 was obtained by comparing value and chroma on the 10YR hue with the percent of organic matter. It was significant at the 1-percent probability level. Sixty percent of the variation in organic matter was explained by value and chroma. Some 170 samples, varying widely in organic matter, were used in the comparison. As a further check, after the chart was developed 120 samples were collected in various parts of the state and found to fit accurately with the chart.

BASIC INFORMATION

The color chart consists of 5 colors, with indicated averages and ranges of organic matter content along with appropriate instructions for using the chart. Several things to keep in mind when using the color chart are:

1. *The soil must be moist.* If it is too wet, water will glisten on the surface and interfere with reading the color; if too dry, the indicated organic-matter content will be too low because dry soil tends to be 1 to 2 units lower in value on the Munsell color charts.
2. *The chart was developed from and intended for use with cultivated surface soils.*
3. *Most accurate estimates of organic matter are obtained by using medium- and fine-textured soils.*
4. *Large amounts of sand will lower the organic matter content for a particular color,* as compared with samples containing low amounts of sand. There is a gradual decrease in organic-matter content for the same color as percent of sand increases from 50 to 100 percent. To get a rough estimate of the organic-matter content in light sandy loams, loamy sand, and sands, divide the indicated organic-matter content in half.
5. *This chart is not intended for use with organic soils.* Ordinarily muck soils may be recognized by being black and soft, while peat soils are brown and fibrous.

COMMENTS

Because of a wide variation in color, this particular color chart will not estimate organic matter accurately in all parts of the world, but it appears to have usefulness where climate and parent materials are similar to those in Illinois.

1/ *Color Chart for Estimating Organic Matter in Illinois Soils,* AG-1941, June, 1968. Cooperative Extension Service, University of Illinois, College of Agriculture, Urbana.

Some organic-matter data and colors from soil descriptions for cultivated soils of other states in the United States have been related to this color chart and found to fit well in many instances. Not all U.S. soils, of course, have been compared, but the preliminary indications are that the color chart should work in Iowa, Wisconsin, Indiana, Kentucky, Wyoming, Kansas, and Mississippi. From a few comparisons made with soils in the New England area, it appears that this chart will *not* be adequate there.

For areas where this particular chart does not work, charts with different colors could be developed that would estimate organic matter.

NEW HERBICIDES FOR 1969

M.D. McGLAMERY

Several herbicides will be discussed that are not new, but which will receive increased emphasis in 1969. Some are combinations of previously cleared herbicides, while some are all new herbicides. Two herbicide trade names have changed during the past year. *Aatrex* is the new trade name for atrazine and *Princep* is the new trade name for simazine.

Lasso (CP-50144) is a new herbicide that may receive clearance in 1969 for both corn and soybeans, Even if these clearances are received, it will be sold primarily for use on soybeans. It will be available as a 4 pounds-per-gallon liquid concentrate and a 10-percent granule. The rate for Lasso will be 1-1/2 to 2-1/2 quarts per acre of liquid of 15- to 25-pounds per acre of the 10-percent granule. Lasso controls about the same weeds as Ramrod, but will give better control of nutsedge. Lasso is less irritating, will give about 2 weeks longer persistence, and will perform better on the lighter soils than Ramrod.

Maloran (C-6313) will be trial marketed in 1969 under an experimental label as a preemergence herbicide for corn. It will be marketed as a 50-percent wettable powder; broadcast rates will vary from 4 to 8 pounds per acre of the commercial formulation (2 to 4 pounds per acre--active ingredient). It will control broadleaved better than grass weeds. Maloran has fair crop tolerance, so the rate will have to be adjusted accurately.

Preforan (C-6989) is a new preemergence herbicide for soybeans. In 1969, it will have a "seed-crop" clearance, which means it cannot be applied to soybeans that are to be used for food, feed, or oil purposes. It will be available as a 3 pounds-per-gallon liquid concentrate; the suggested broadcast rate is 5 to 6 quarts per acre. It looks promising for the control of some broadleaved weeds in soybeans, but further research will be required to determine its exact control spectrum.

Sutan (butylate) is a preplant, incorporated herbicide for corn. It will probably replace Eptam for Johnsongrass seedling and wild cane control in corn. It will take care of most annual grass weeds, but its broad-leaved weed control is fair to poor, depending on the rate and conditions. Yellow nutsedge control will be fair to good, also depending on the rate and conditions.

Sutan will be available as a 6 pounds-per-gallon liquid concentrate and a 10-percent granule. The suggested broadcast rate will be 4 pounds per acre (active ingredient). It should be incorporated soon after application to prevent volatile loss.

Sutan plus Atrazine is a "tank-mix" preplant combination for corn. A prepackaged mixture will not be available in 1969. The combination provides a broad spectrum of weed control, allowing the use of a reduced rate of atrazine. The present supplemental label covers only a 3:1 ratio (a.i.), but clearance is pending for a 3:1-1/2 combination. The tank mix of commercial formulation will be 1/2 gallon of Sutan and 1-1/4 to 2 pounds of atrazine 80W per acre, on a broadcast basis. Incorporation after application is necessary to prevent loss of the Sutan.

Ramrod plus Atrazine will be available in 1969 as a prepackaged mixture, or you can tank-mix the combination. The mixture will be packaged in a novel plastic bag, suitable for premixing the water and wettable powder. The active ingredient of the wettable powder mixture is 48.1-percent Ramrod and 20.9-percent atrazine. The suggested broadcast rate will be 5 to 8 pounds per acre of packaged mix, depending on the soil type and organic-matter content.

The combination can be tank-mixed by purchasing the two ingredients separately. This will allow a variation of the ratio, depending on the soil type. The usual tank mix is to add 4-1/2 pounds per acre of Ramrod 65W regardless of the soil type. You will need to adjust the atrazine 80W rate from 1-1/4 to 2 pounds per acre, depending on the soil type.

The Ramrod plus Atrazine combination controls broad-leaved weeds better than Ramrod alone, and it often controls annual grass weeds better than atrazine alone--especially on high organic-matter soils. It reduces the atrazine residue problem, giving more-consistent control on the darker soils or with limited rainfall than does atrazine alone.

Primaze is a 1:1 combination of prometryne and atrazine. It will be sold for preemergence use on corn grown in rotational programs, where atrazine carry-over has been a major concern. The label suggests that soybeans and oats can be grown the following spring after the use of the combination on corn. It will be sold only as an 80-percent wettable powder; the suggested rate will be 2 to 3-3/4 pounds of the 80W, depending on the soil type.

Londax is a combination of Ramrod and Lorox for use on corn. It contains Lorox and Ramrod in a 1:2 ratio (a.i.), and will be available as a wettable powder and a 15-percent granule. It will add another choice to the broad-spectrum granular herbicides available for corn. Control of broad-leaved weeds will be better than with Ramrod alone, and crop tolerance is better than with Lorox alone.

WATER WEED CONTROL

ROBERT C. HILTIBRAN

Last year, I mentioned that two cases had been brought to my attention in which commercial application had been made using aquatic herbicides for the control of spatterdock, *Nuphar advena,* and waterstargrass, *Heteranthera dubia,* without success.

SPATTERDOCK

In 1967 we found the liquid ester formulations of 2,4-D, 2,4,5-T, and silvex at rates of up to 40 pounds per acre were not very effective for the control of spatterdock. Granular ester 2,4,5-T and silvex at rates of 80 pounds per acre substantially reduced the spatterdock within the treated area, but did not completely eliminate it. Combinations of a granular application 2,4,5-T on silvex followed by applications of liquid 2,4,5-T on silvex at the above rates were not any more effective than the granular herbicides alone.

We noted in 1968 that in some of the areas treated with granular 2,4,5-T or silvex, the spatterdock had been substantially reduced in the center of the treated area but was growing around the edges. In 1968 we applied granular 2,4-D or silvex to the margins of the 1967 test areas at the same rate. Granular silvex was slightly more effective than the granular 2,4-D. Over a two-year period (1967 and 1968), spatterdock has not been eliminated from any test area. Liquid ester formulations of 2,4-D, 2,4,5-T, and silvex caused some initial knockdown of the spatterdock but did not give any lasting effect. Spatterdock stands were reduced in the areas treated with the granular ester formulations. Granular 2,4,5-T and silvex were more effective than granular 2,4-D.

Granular dichlobenil at rates of 10 and 12 pounds per acre applied in mid-July and mid-August substantially reduced the spatterdock within the treated areas within four weeks. These areas will be checked in 1969. In Florida, dichlobenil has been very effective against spatterdock.

WATERSTARGRASS

In 1967 we found that waterstargrass within the treated area could be eliminated by the application of diquat at a rate of 1 part per million. In 1968 we found that diquat at a rate of 0.5 p.p.m. did not eliminate the waterstargrass from the treated area, but some damage was noted. Diquat at a rate of 1 gallon per surface acre, eliminated the waterstargrass from the treated area.

Previously, we had reports that endothal was not very effective for the control of waterstargrass. However, other reports indicated just the contrary. We did not test the effect of endothal on waterstargrass in 1967, but in 1968 we found that liquid potassium endothal at a rate of 5 p.p.m. eliminated waterstargrass from the test area; the rate of 2.5 p.p.m. did not. Some damage was noted, however, in the later test area. We need to check the effectiveness of the disodium salt of endothal on waterstargrass in Illinois.

NEW AQUATIC HERBICIDE SYSTEMS

The Aquatic Herbicide System E developed by the 3M Company was tested in 1968 for the first time. This system consisted of the dihydroxy aluminum salt of endothal on a mica carrier. The abbreviation of endothal DASM has been suggested. Two formulations were available to us: one, a wettable powder containing a 15-percent acid equivalent of endothal; the second, a slurry containing a 5-percent acid equivalent of endothal. Only the data obtained using the wettable powder formulation will be presented.

The 3M Company also developed two other systems--Aquatic Herbicide System S and Aquatic Herbicide System 24. These consist of monohydroxy aluminum salt of silvex or 2,4-D. The abbreviations of silvex (MASM) and 2,4-D (MASM), respectively, have been suggested. Originally, we had planned to test all three systems, but had to take one. We selected the endothal DASM system. We hope to test the other two systems later.

The endothal DASM at rates of 0.25, 0.50, and 1 p.p.m. endothal content was applied to nine 50-foot-square test areas in Miller Pond on June 11, 1968. In June, Miller Pond had a severe infestation of small pondweed. The areas were set out in groups of three, in three different areas of the 5-acre pond, with buffer strips from 10 to 20 feet in width between test sites. The appropriate amount of wettable powder was diluted with 2 gallons of water and applied with a 3.5-gallon garden sprayer. Seventeen days later, the small pondweed had been eliminated from all the test areas, from all the buffer strips, and for various distances from the original test sites. From these areas, it was not possible to determine the effectiveness of the different rates of endothal DASM on small pondweeds.

In previous years, the leafy pondweed plants in Whetzel Pond and the curlyleaf pondweed *(P. crispus)* plants in Mansion Pond had been removed by applying small amounts of granular endothal directly to the isolated plants or to small groups of plants. Using this technique, the leafy pondweed and curlyleaf pondweed, although not completely eliminated, were prevented from becoming serious problems in Whetzel Pond and Mansion Pond. During 1968 small amounts of endothal DASM were applied to isolated plants or groups of plants in Whetzel Pond and Mansion Pond. In both ponds the pondweeds were eliminated, without treating large areas of water that contained a relative small number of plants. Although water was dispersed, it was possible to place the herbicide at the desired place, i.e. directly in contact with the plants. No doubt, this provided a suitable concentration of herbicide in the immediate vicinity of the plant.

SPRAY CHARACTERISTICS OF A NEW LOW-VOLUME APPLICATOR

JOHN C. SIEMENS

Most herbicides must be diluted with water or some other liquid, in order to get uniform coverage when applied with common sprayers. Handling the amount of water required is a significant disadvantage for liquid herbicides. A new, low-volume applicator (LVA) developed by Amchem Products, Inc. of Ambler, Pennsylvania, may eliminate the necessity of diluting liquid herbicides.

GENERAL DESIGN

The LVA was designed specifically for applying Amiben as a preemergence spray in a band over the row at planting time. It may also be useful for other chemicals. A one-gallon container of the chemical is placed on the LVA, which is mounted behind each row of the planter. One tube that passes through the container cap serves as a constant head device. Another tube used to siphon the liquid from the container is connected to a brass tube that contains a changeable orifice and passes through the hollow armature shaft of a 12-volt d.c. motor. The only function of the motor is to spin the nozzle located at the bottom of the brass tube.

A rheostat is used in conjunction with the motor to adjust the nozzle speed.

THE NOZZLE

The nozzle used for these tests had four 0.028-inch-diameter outlet holes, oriented so that the chemical left the nozzle with a horizontal velocity only. The unit was designed to give a band width of 12 to 14 inches, with the nozzle positioned 5-1/2 inches above the ground surface and spinning at 3,500 r.p.m.

FACTORS INVESTIGATED

Factors investigated were (1) the change in flow rate as the container emptied, (2) the effect of nozzle speed on flow rate and band width, (3) the chemical distribution across the band, (4) droplet size, and (5) drift.

EFFECT OF LIQUID LEVEL ON FLOW RATE

The flow rate varied only 3 percent as the container emptied, and the variation was not correlated to the liquid level in the container. However, it was necessary to be sure the passages were free of foreign particles.

EFFECT OF NOZZLE SPEED ON FLOW RATE AND BAND WIDTH

As the nozzle speed increased from 2,000 to 4,200 r.p.m., the flow rate increased from 73 to 87 cc./min., while the band width increased from 8 to 16 inches. The increased band width was expected because the spinning nozzle imparts a centrifugal force on the liquid and is the major cause of the horizontal velocity of the droplets leaving the nozzle. The increased flow rate results from the increased differential pressure across the orifice. Since the flow rate increased only slightly while the band width doubled, the application rate decreases as the nozzle speed is increased.

DISTRIBUTION

The distribution of the liquid across the band was found to peak near the edges of the band. A typical distribution is shown below for one-half of the band.

Inches from nozzle	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8
Percent collected	11	11	11	12	15	19	17	4

DROPLET SIZE

The average droplet size was found to be approximately 540 microns. For an application rate of one gallon per acre with this droplet size, there would be an average of 7.3 droplets per square inch. Field experiments at the University of Illinois showed no difference in the degree of weed control, where amiben applied undiluted was compared with amiben diluted with water and applied with a conventional sprayer.

DRIFT

Drift tests were conducted in the field with the LVA unit mounted on a four-row planter. With a planter speed of 3 m.p.h. and a crosswind of about 10 m.p.h., the spray band shifted about 4 inches. Since such crosswinds are common, it may be necessary to add shields.

SEED-CORN MAGGOT RESISTANCE TO ALDRIN

C.R. HARRIS

The seed-corn maggot is a serious pest of field and vegetable crops in many areas of the Midwestern United States and in Canada. It is closely related to the other common species of root maggots, such as the onion and cabbage maggots. All three of these species were easily controlled with the cyclodiene insecticides, such as aldrin, dieldrin, and heptachlor. However, in the late 1950's and early 1960's, the onion and cabbage maggots both became resistant to aldrin, dieldrin, and heptachlor; consequently, it became necessary to find alternative insecticidal controls. The seed-corn maggot remained susceptible to these insecticides for several more years, although a collection of seed-corn maggot flies taken in 1964 in the tobacco-growing areas of southwestern Ontario indicated that this species was also beginning to show signs of resistance to the cyclodiene insecticides (Table 1).

Table 1. Direct Contact Toxicity of Aldrin to Adults of a Susceptible Chatham Laboratory Strain of Seed-Corn Maggot, and a Strain Collected Near Delhi, Ontario, 1964

	Average corrected pct. mortality			
	Pct. insecticide solution			
Strain	.001	.01	.1	1.0
Chatham	0	100	100	100
Delhi	0	59	88	95

As you can see, 0.1-percent aldrin completely killed the susceptible laboratory strain of flies, but only 59 percent of the field-collected Delhi strain. Even the higher concentrations of 0.1 and 1.0 percent killed only 88 and 95 percent, respectively. This was the first instance of resistance in the seed-corn maggot. Yet, in the same year, resistance to aldrin was also detected in British Columbia. The population in Ontario was only partially resistant to aldrin. In actual fact, 59 percent of the population was still susceptible, 29 percent was intermediate in the level of resistance, and only 12 percent was truly resistant. However, past experience has taught us that once resistance appears (even at a very low level), the toxic residues in the soil will rapidly select out the susceptible and hybrid individuals in the population and produce a highly resistant strain. Since it was obvious that it would be necessary to find an alternative control measure in the near future, we "selected" our "slightly resistant" strain in the laboratory with aldrin. Within a period of two generations, we were able to produce a strain that was totally resistant to aldrin and the other cyclodiene insecticides.

Subsequently, we tested this strain and compared the results with our susceptible laboratory strain. The "bioassay" lines obtained in the laboratory are shown in Figure 1. You will note that the original Delhi strain is highly resistant to the aldrin, but not to DDT or diazinon. The actual level of resistance to aldrin is shown in Table 2. The resistant seed-corn maggots were able to tolerate a dosage of aldrin 727 times as great as the aldrin-susceptible strain. There was no sign of cross-resistance to either DDT or diazinon.

It was apparent that the level of resistance which the seed-corn maggot would develop to aldrin would necessitate the development of alternative insecticidal controls.

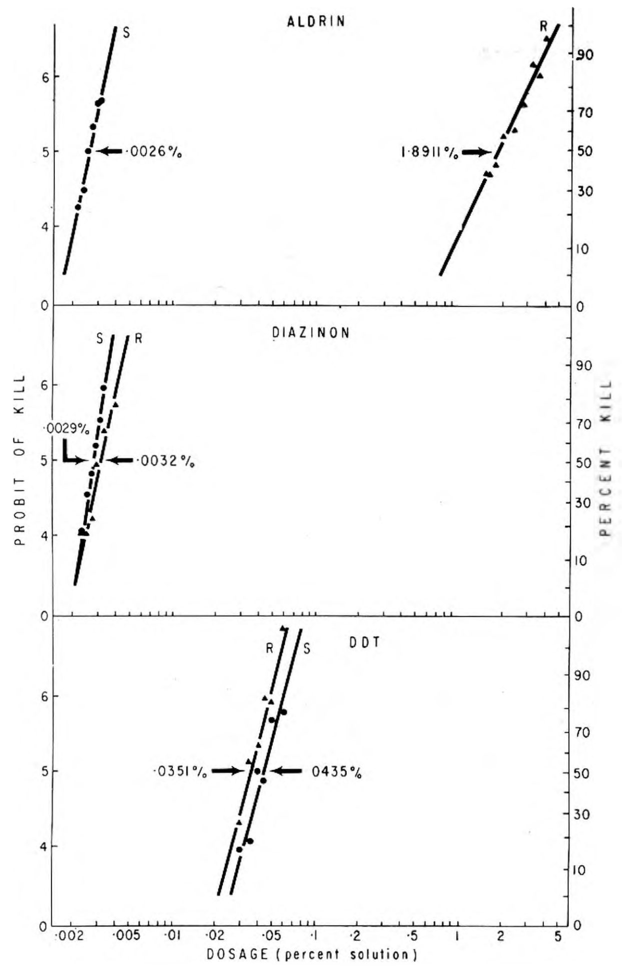


Figure 1. Regression lines for aldrin, DDT, and diazinon--using adults of the cyclodiene-susceptible and cyclodiene-resistant strains of the seed-corn maggot.

The presence of resistance to aldrin, dieldrin, and heptachlor was confirmed in Canada in 1964. At that time, it had not developed to the point in the United States where it constituted a problem. Between 1964 and 1968, however, several investigators in the U.S. began to note that the aldrin, heptachlor, or dieldrin seed-treatments being used in several areas were failing to provide completely satisfactory maggot control. In the summer of 1968, a cooperator in Illinois submitted a sample of seed-corn maggots to us for testing. His field studies indicated that dieldrin was no longer effective, and he suspected that the seed-corn maggot had become resistant to the cyclodiene insecticides in Illinois. As a result of our tests in the laboratory, we were able to confirm that resistance had developed to aldrin (Table 3).

Based on what we call "discriminating dosages," it was apparent that the strain collected in Illinois was 40-percent susceptible, 50-percent intermediate in the level of resistance to aldrin (hybrids), and 10-percent totally resistant (homozygous). The Illinois strain was, however, still susceptible to both DDT and diazinon. This is a picture very similar to that obtained in Ontario in 1964 (Tables 1 and 2 and Figure 1).

When resistance develops to material like aldrin, cross-resistance will often occur to other, closely related insecticides. The materials that are related to aldrin include dieldrin, endrin, heptachlor, and even lindane. We conducted tests with some of these on the aldrin-resistant strains. The data in Table 4 indicate that there is cross-resistance to dieldrin, chlordane, and even to lindane. In addition, we have always found that where cross-resistance occurs to those particular materials, it is also present with heptachlor and endrin. Thus, *none* of these materials (aldrin, dieldrin, endrin, heptachlor, chlordane, or lindane) will be effective in areas of Illinois where seed-corn maggot resistance to any of them has developed.

Consequently, alternative insecticides must be found. In our laboratory screening program for the development of new soil insecticides, we have identified a number of materials that appear to be effective in soil. We screened a number of these compounds against adults of the resistant strain of the seed-corn maggot.

Table 2. Toxicity of Aldrin, DDT, and Diazinon to Cyclodiene-Susceptible and Homozygous Resistant Strains of the Seed-Corn Maggot

Insecticide	Culture	LD_{50} a/ (% solution)	Resistance level at LD_{50}
aldrin	S b/	0.0026	x 727.4
	R c/	1.8911	
DDT	S	0.0435	x 0.8
	R	0.0351	
diazinon	S	0.0029	x 1.1
	R	0.0032	

a/ Lethal dosage causing 50-percent mortality.
b/ Susceptible strain.
c/ Resistant strain.

Table 3. Toxicity of Aldrin, DDT, and Diazinon to Cyclodiene-Susceptible and Resistant Strains of the Seed-Corn Maggot

		Average corrected pct. mortality			
		Pct. insecticide solution			
Insecticide	Strain	.001	.01	.1	1.0
aldrin......	Chatham S a/	0	100	100	100
	Illinois	0	40	90	90
	Chatham R b/	0	0	0	26
DDT........	Chatham S	0	0	100	100
	Illinois	0	0	80	100
	Chatham R	0	0	100	100
diazinon....	Chatham S	0	100	100	100
	Illinois	5	100	100	100
	Chatham R	0	100	100	100

a/ Susceptible strain.
b/ Resistant strain.

The results of these tests indicated that a number of materials are highly toxic to seed-corn maggot adults (Table 5). Thus, it would appear likely that it should not be difficult to develop an alternative method of seed treatment to replace the cyclodiene insecticides for seed-corn maggot control. One possible problem will be that a number of these new organophosphorous and carbamate insecticides may be phytotoxic.

In 1963 when the first signs of resistance were appearing in Ontario, we did not have the choice of experimental materials listed in Table 5. Consequently, the only materials which we could recommend for field trials were diazinon and DDT (Table 3). A colleague of mine, the late J.A. Begg, tested these two materials as seed treatments for resistant seed-corn maggot. The insecticides, in combination with a fungicide, were applied as slurries. Four replicates of 100 seeds each of white beans and sweet corn were planted with a V-belt seeder. The effectiveness of the treatments was based in seedling emergence (Table 6). The results showed that diazinon, in combination with either thiram or captan, provided good protection. Increasing the rate from 0.5 to 1.0 ounce of actual diazinon per 100 pounds of seed did not increase the degree of control. It should be noted, however, that these tests were conducted on a light, sandy soil. DDT seed treatment increased the emergence of sweet corn, but was relatively ineffective on white beans. The cyclodiene insecticide, aldrin, gave little control of the resistant strain.

Table 4. Cross-Resistance Shown by the Aldrin-Resistant Strains of Seed-Corn Maggot

		Average corrected pct. mortality			
		Pct. insecticide solution			
Insecticide	Strain	.001	.01	.1	1.0
dieldrin.....	Chatham S	0	100	100	100
	Illinois R	0	25	75	90
	Chatham R	0	0	0	58
chlordane....	Chatham S	0	5	100	100
	Chatham R	0	0	0	0
lindane......	Chatham S	0	100	100	100
	Chatham R	0	0	30	100

Table 5. Toxicity of Some Promising Organophosphorous and Carbamate Insecticides to Aldrin-Resistant, Seed-Corn Maggot Adults

	Average corrected pct. mortality			
	Pct. insecticide solution			
Insecticide	.001	.01	.1	1.0
Bay 37289	0	100	100	100
Bay 77488	0	100	100	100
Bay 78182	0	100	100	100
Birlane	0	100	100	100
CL-72499	0	100	100	100
Dasanit	0	100	100	100
diazinon	0	100	100	100
Dursban	0	100	100	100
Furadan	0	100	100	100
phorate	0	20	100	100
N-2596	0	10	100	100
Disyston	0	0	100	100

Table 6. Effectiveness of Seed Treatments for the Control of Aldrin-Resistant Seed Maggots Attacking White Beans and Sweet Corn Seed

Formulation, WP		Oz. actual per acre		Mean pct. emergence	
Insecticide	Fungicide	Insecticide	Fungicide	Beans[a]	Sweet corn[a]
diazinon 25% +	thiram 75%	1.0	1.5	83	50
diazinon 25% +	thiram 75%	0.5	1.5	85	56
diazinon 12.5% +	captan 37.5%	0.5	1.5	87	61
DDT 50% +	thiram 75%	0.5	1.5	25	47
aldrin 50% +	thiram 75%	0.5	1.5	21	28
...	thiram 75%	...	1.5	9	21
Control (untreated)		...	...	6	14

a/ Percent of germination, 92 and 67, respectively.

Diazinon at 0.5 ounce per 100 pounds of seed, in combination with a fungicide, has been highly effective in protecting seeded crops from maggot attack in Ontario since 1964. However, the treatment was not adequate for the control of wireworms. In 1965, we recommended lindane at 1 ounce per 100 pounds of seed, in combination with diazinon and the fungicide for control of resistant maggots and susceptible wireworms attacking seeded crops. Laboratory and field trials conducted at the Western Ontario Agricultural School, Ridgetown, Ontario, indicated that the combination had no adverse effect on the germination of hybrid field and sweet corn, soya, white and lima beans, wheat, oats, barley, or cucumber seed. This combined seed-maggot and wireworm recommendation has provided very effective control since that time.

SEED-CORN BEETLES

STEVENSON MOORE, III AND H.B. PETTY

Two species of seed-corn beetles are present in Illinois: the chestnut brown, *Clivina* sp. and the slightly larger, dark-brown, striped *Agonoderus* sp. The adults hollow out the germinated seed, gouge the sprouts, and may even cut them off.

HISTORY

In 1967, six fields of corn treated with a chlorinated hydrocarbon insecticide were severely damaged by seed-corn beetles. In 1968, several hundred fields of corn treated with aldrin, heptachlor, chlordane, lindane, and dieldrin as a soil or seed treatment were known to have been economically damaged by these same insects. There is little doubt, although it is not a proven fact, that many seed-corn beetles are already resistant or rapidly developing resistance to the chlorinated hydrocarbon insecticides.

PRESENT SITUATION

No one knows for certain what percentage of fields are presently affected. A random survey of a limited number of cornfields showed that in 36 percent of these fields, seed-corn beetles were not controlled by an aldrin soil treatment.

Many farmers, unaware of this problem, blamed poor germination and irregular stands on the cool, wet weather.

In at least two instances in Illinois, resistance to aldrin, heptachlor, chlordane, dieldrin, and lindane has been confirmed for the seed-corn maggot--another seed-attacking pest.

A few, rather limited control tests were conducted on the seed corn beetle problem in 1968. Conclusions based on this data should be made with reservation.

Several phosphate and carbamate insecticides were applied to 14 cornfields at planting time at the rate of 1 pound per acre of actual chemical to the soil surface in a 7-inch band over the row. In some of the fields, aldrin was applied as a preplant or row treatment. In the remaining fields, there was no aldrin plot. The stand counts were quite similar for the aldrin and the untreated plots. Considering this, the aldrin and untreated plots were averaged and recorded as the aldrin check.

Clivina and *Agonoderus* spp. of seed beetles were present in several of the fields, but no beetle counts were made. Neither wireworms not cutworms affected stands in these fields.

In the Dasanit, diazinon, dyfonate, Furadan, and phorate plots, stand counts were higher than in the aldrin check plots (Table 1).

BUXten and Mocap did not appear to give protection against seed-corn beetles, since stand counts in these plots were less than the aldrin check plots. It is also possible that these two insecticides were somewhat injurious to germinating seeds, causing a stand reduction that more than offset any gains derived from the control of seed-corn beetles.

A cornfield in western Illinois that was planted in early May and treated with 2 pounds of actual aldrin per acre broadcast and disked-in before planting was severely damaged by seed-corn beetles.

Several phosphate insecticides were applied from the planter at 1 pound of actual per acre in a 7-inch band over the row. Dyfonate, diazinon, Dasanit, and phorate all gave adequate protection of the germinating seed and seedling plants from attack by seed-corn beetles (Table 2).

A heptachlor soil treatment failed to control seed-corn beetles in a field in central Illinois. At replanting, 3 ounces of 50-percent diazinon wettable powder plus 1-1/2 ounces of graphite were applied to a bushel of seed. In the diazinon plots, there was an average of 4,900 more plants per acre than in the untreated plots, indicating that the diazinon seed treatment provided adequate protection of the germinating seed from attack by seed-corn beetles (Table 3).

SEED TREATMENT GERMINATION TESTS

Diazinon 50-percent wettable powder was applied at 4, 8, 16, and 48 ounces per 100 pounds to 100 seeds of two hybrids. Fifty-percent captan wettable powder was added at the rate of 2 ounces per 100 pounds of seed. The excess powder was sifted over the seed, which was then covered with dirt. After that, they were then subjected to the cold germination test.

Germination effect was noticed at the 16- and 48-ounce levels, but not at the lower rates.

Commercially prepared seed-treatment materials containing lindane, diazinon, and both were also tested. There was little if any response to diazinon. The response to lindane appeared as corkscrew growth. However, combinations of these two did

Table 1. Effect of Several Organic Phosphate and Carbamate Insecticides Against Seed Infesting Insects in 14 Illinois Cornfields, 1968.

Insecticide and dosage	Plants per acre	Additional plants per acre above aldrin check
Aldrin and check av.	21,114	...
BUXten, 1 lb./acre	20,946	-168
Dasanit, 1 lb./acre	21,356	242
Furadan, 1 lb./acre	21,403	289
Phorate, 1 lb./acre	21,436	322
Dyfonate, 1 lb./acre	21,608	494
Diazinon	21,995	881
Mocap, 1 lb./acre 1/	20,241	
Check	21,289	-1,048

1/ Thirteen fields only.

give an effect on deleterious growth and germination. Therefore, when using combinations of these materials, adhere to the manufacturer's recommendations, even though the rate of diazinon is lower than we suggest.

OUTLOOK

In the future, Illinois farmers should not depend on the chlorinated hydrocarbon insecticides--aldrin, heptachlor, chlordane, dieldrin, or lindane--as soil or seed treatments to protect germinating corn seed from attack by the seed-corn beetle or maggots. These insects can be controlled with a diazinon seed treatment or with planting applications over the row of Dasanit, diazinon, Dyfonate, phorate, or Furadan (if label approval is granted). BUXten does not appear to give adequate protection against seed-corn beetles. We have no data on seed-corn beetle or maggot control by the use of planter applications of carbaryl, disulfoton, or parathion.

Table 2. Effect of Several Organic Phosphate Insecticides as Planter Treatments Against Seed-Corn Beetles

Insecticide and dosage	Plants per acre	Additional plants per acre above untreated plot
Untreated	17,650	...
Dyfonate, 1 lb./acre	18,900	1,250
Diazinon, 1 lb./acre	20,950	3,300
Dasanit, 1 lb./acre	21,350	3,700
Phorate, 1 lb./acre	21,850	4,200

Table 3. Effect of Diazinon as a Seed Treatment Against Seed-Corn Beetles

Insecticide	Plants per acre	Additional plants per acre above untreated plot
Untreated	16,900	...
Diazinon, 1.5 oz. actual/bu.	21,500	4,900

Table 4. Seed Treatment Germination Tests

Treatment	Ounces per 100 lb.	Percent germination
Nothing	...	72.0
Captan	1	96.0
Diazinon 50-percent wettable powder with Captan	4 (2 oz. actual)	94.0
	8 (4 oz. actual)	92.0
	16 (8 oz. actual)	79.0
	48 (24 oz. actual)	76.0

SURVEY OF NORTHERN AND WESTERN CORN ROOTWORM ADULT POPULATIONS, 1968

D.E. KUHLMAN

This summer, for the fourth consecutive year, we conducted a random survey of 225 cornfields in 23 counties to assess the levels and the distribution of the western and northern corn rootworm adult populations. The surveys of previous years were undertaken to determine the extent of corn rootworm resistance to chlorinated hydrocarbons, along with the abundance and the distribution of rootworm populations. This year, we regarded all northern corn rootworms as resistant to aldrin and heptachlor throughout Illinois. Consequently, there was no resistance study this year.

BASIC APPROACH

The state was divided into three regions for the survey. Nine counties were surveyed in the northern third of Illinois; seven in central Illinois; and seven in the southern half of the state.

The objectives of the survey were to determine (1) whether corn rootworm populations are increasing, declining, or remaining stable; (2) insecticide use; (3) the extent of continuous corn acreage; and (4) rootworm populations as these relate to cropping practices.

SURVEY PROCEDURE

The adult rootworm survey was made during the second week of August. Beetle counts were made in each field on 25 plants selected at random. The counts included the average number of beetles per ear plus the average number of beetles present on the remainder of the corn plant. For the purposes of this report, the sum of "beetles per ear" plus "beetles per plant" is reported as the "average number of beetles per plant." County Extension advisers obtained the cropping and soil-treatment history for the fields. The following counties were surveyed:

District

Northwest..........Lee, Mercer, Ogle, Stephenson, Whiteside
Northeast..........Boone, DeKalb, Kane, LaSalle
West...............Henderson, McDonough, Warren
East-central.......Champaign, Iroquois, Livingston, McLean
West-southwest.....Greene, Macoupin, Montgomery
East-southeast.....Gallatin, Shelby, Wabash, White

We wish to thank the Extension adviser of the counties listed above for their assistance in obtaining data.

CORN ROOTWORM ABUNDANCE AND DISTRIBUTION

The highest 1968 corn rootworm populations were found in the northeast, northwest, and west sections of Illinois. Populations in the east-central district increased slightly, and the number of rootworms in the southern half of Illinois remained low (Table 8).

The western corn rootworm continues to spread and increase in abundance. This year, western corn rootworm beetles were found in 58 of 225 fields on the survey (Table 7). Westerns were found in only 1 of 40 fields surveyed in the northeast district, but 72 percent of the fields in the northwest district and 84 percent of the fields in the west district had western corn rootworm adults.

Rootworm populations averaged 1 or more beetles per plant in 60 percent or more of the cornfields surveyed in the northeast, northwest, and west sections (Table 8).

How many beetles should you find to predict problems next year? We do not know; but 1 per plant is a start, and 3 or more per plant could lead to serious problems. Following this line of reasoning, 20 percent or more of the fields in the northeast and northwest districts will be damaged by rootworms in 1969 (Table 8).

Rootworm population trends for the period 1966 to 1968 are given in Table 6. The populations of rootworm adults have increased in the northern and central regions, particularly in the range of 1 to 3 beetles per plant. In the northern third of Illinois, the percent of fields with 1 to 3 beetles per plant increased from 15 to 39 percent; in the central area, from 13 to 40 percent. Rootworm populations in the southern one-half of Illinois have remained low for the past three years.

ROOTWORM POPULATIONS AS THEY RELATE TO ROTATION AND INSECTICIDE USE

The crop-rotation and soil-insecticide history was obtained for 167 of the 225 fields selected at random for the survey. A summary of the number of fields treated and of rootworm populations, by district and state, is presented in Tables 1 and 2.

Table 1. Adult Corn Rootworm Populations as Related to Crop Rotations and Soil-Insecticide Treatment, by Districts, 1968

Average no. of beetles per plant	Number of fields according to years in corn and soil treatment[a]							
	1 year		2 years		3 years		4 years	
	Untr.	Tr.	Untr.	Tr.	Untr.	Tr.	Untr.	Tr.
				Northeast				
0	..	..	..	..	..	..	..	..
0.1 to 1.0	4	2	..	1	..	..	..	..
1.1 to 3.0	1	2	..	3	..	..	..	3
3.1+	..	..	1	1	..	..	..	3
Total	5	4	1	5	..	..	..	6
				Northwest				
0	..	..	..	..	..	..	..	1
0.1 to 1.0	..	2	..	4	..	1	..	4
1.1 to 3.0	..	2	..	6	..	3	2	6
3.1+	..	1	1	1	1	1	..	3
Total	..	5	1	11	1	5	2	14

Table 1. (continued)

Average no. of beetles per plant	Number of fields according to years in corn and soil treatment[a/]							
	1 year		2 years		3 years		4 years	
	Untr.	Tr.	Untr.	Tr.	Untr.	Tr.	Untr.	Tr.
				West				
0	..	..	..	..	..	..	..	..
0.1 to 1.0	1	2	..	1	..	..	..	2
1.1 to 3.0	2	..	2	1	..	..	..	4
3.1+	..	..	..	..	..	..	..	..
Total	3	2	2	2	..	..	..	6
				East-central				
0	..	..	..	..	..	..	..	..
0.1 to 1.0	4	2	..	2	..	1	1	1
1.1 to 3.0	7	2	2	..	1	..	..	..
3.1+	1	..	..	..	..	..	1	..
Total	12	4	2	2	1	1	2	1
				East-southeast				
0	2	1	2	4	..	2	1	5
0.1 to 1.0	3	2	3	2	3	1	3	5
1.1 to 3.0	..	1	..	..	..	..	..	..
3.1+	..	..	..	..	..	..	..	..
Total	5	4	5	6	3	3	4	10
				West-southwest				
0	8	4	1	3	..	1	..	1
0.1 to 1.0	2	2	..	2	1	..	..	..
1.1 to 3.0	1	1	..	..	..	..	..	..
3.1+	..	..	..	..	..	..	..	..
Total	11	7	1	5	1	1	..	1

a/ Includes chlorinated hydrocarbons, organic phosphates, and carbamates.

Table 2. Summary of Adult Corn Rootworm Populations in Relation to Crop Rotation and Soil-Insecticide Treatment for 167 Fields, 1968

Average no. of beetles per plant	Number of fields according to years in corn and soil treatment[a/]							
	1 year		2 years		3 years		4 years	
	Untr.	Tr.	Untr.	Tr.	Untr.	Tr.	Untr.	Tr.
0	10	5	3	7	..	3	1	7
0.1 to 1.0	14	12	3	12	4	3	4	12
1.1 to 3.0	11	8	4	10	1	3	2	13
3.1+	1	1	2	2	1	1	1	6
Total	36	26	12	31	6	10	8	38

a/ Includes chlorinated hydrocarbons, organic phosphates, and carbamates.

Examination of the data shows that 65 percent of the fields averaging 1 or more beetles per plant were treated with a soil insecticide. We do not know if the beetles present were migratory or were inherent to a particular field. Twenty-one fields of first-year corn averaged 1.1 or more beetles per plant. While there may have been little or no damage by rootworms to the first-year corn, this population could be sufficient to cause a problem in second-year corn.

CROP ROTATIONS

The highest corn rootworm populations are usually found where continuous corn is grown. The areas with the highest percentage of continuous corn (Table 3) and the highest rootworm populations (Table 8) are in the northwest, northeast, and west districts. The low rootworm populations in the east-central and west-southwest sections closely correlate with the high percentage of fields in first-year corn. An exception was in the east-southeast section of Illinois, where 50 percent of the fields are in third-year corn or beyond, but rootworm populations were very low.

Table 3. Percent of Fields in Continuous Corn, by District, 1968

District	No. of fields	Years in corn			
		1	2	3	4+
		Percent of fields treated			
Northeast	21	43	28	..	29
Northwest	39	13	31	15	41
West	15	33	27	..	40
East-central	25	64	16	8	12
West-southwest	27	67	22	7	4
East-southeast	40	23	27	15	35
Average	167	37	26	10	27

A comparison of crop rotations for 1966 and 1968 shows that farmers in the problem area (the northern third of Illinois) are staying with continuous corn and are using organic phosphate and carbamate insecticides for rootworm control. Forty percent of the fields surveyed in 1966 were in third-year corn or beyond. In 1968, this figure was 37 percent.

INSECTICIDE USE

In 1968, farmers reported using a soil insecticide on 63 percent of their corn acreage (Table 5). This is based on a survey of 167 fields. A 1966 survey showed 62 percent using a soil insecticide. However, during the past three years, there has been a shift from the chlorinated hydrocarbons to organic phosphate and carbamate insecticides for resistant rootworm control. The 1968 survey shows that 15 percent of the fields were treated with an organic phosphate or carbamate insecticide; 44 percent with a chlorinated hydrocarbon; and 4 percent with combinations of an organic phosphate and chlorinated hydrocarbon. In 1966, only 2 percent of the fields were treated with an organic phosphate, while 60 percent were treated with aldrin or heptachlor.

A summary of the fields treated with soil insecticides, by districts, is presented in Table 5. In the primary rootworm area (the northeast, northwest, and west districts), between 40 to 43 percent of the fields were treated with organic phosphates or carbamates, while none were reported in the non-rootworm area. The use of chlorinated hydrocarbons in 1968 declined in the problem area, remaining about the same in the west-southwest and east-southeast districts in comparison with the 1966 survey. Some 68 percent of the corn in the east-central district was untreated.

Farmers used a soil insecticide on 83 percent of all fourth-year continuous corn, but only 42 percent of the first-year corn was treated (Table 4). This indicates that farmers encounter fewer rootworm problems on first-year corn than on continuous corn. However, other soil insects are bothersome; consequently, soil-insecticide treatment cannot be entirely ignored on first-year corn.

Table 4. Percent of Fields Treated With a Soil Insecticide as Related to Years in Continuous Corn, 1968

		Years in corn			
	No. of	1	2	3	4+
District	fields	Percent of fields treated			
Northeast	21	44	83	..	100
Northwest	39	100	91	83	88
West	15	40	50	..	100
East-central	25	25	50	50	33
West-southwest	27	39	83	50	100
East-southeast	40	44	55	50	71
Average	167	42	72	63	83

SUMMARY

1. Thirty-seven percent of the fields were in third-year corn or beyond (Table 3).

2. Only 42 percent of the first-year corn was treated with a soil insecticide, but 83 percent of fourth-year corn or beyond was treated (Table 4).

3. Forty-four percent of the fields were treated with chlorinated hydrocarbon soil insecticides; 15 percent with organic phosphates or carbamates; 4 percent with combinations; and 37 percent were untreated (Table 5).

Table 5. Percent of Fields Treated With Soil Insecticides, by District, 1968

Treatment	District: Northeast	Northwest	West	East-central	WSW	ESE	Percent of all fields
	Percent of fields treated						
None	29	10	33	68	48	43	37
Aldrin or Heptachlor	28	49	27	32	52	57	44
Organic Phosphate or Carbamate	24	33	40	0	0	0	15
Combinations	19	8	0	0	0	0	4
							100

4. Rootworm beetle populations increased during the period 1966 to 1968. This year, 39 percent of the fields averaged 1 to 3 beetles per plant; 20 percent averaged 3 or more beetles per plant in northern Illinois (Table 6).

Table 6. Adult Rootworm Population Trends, 1966-1968

Region	Year	No. of fields	Average number of beetles per plant: 0-1	1-3	3-5	5+
			Percent of fields treated			
N. Ill.	1966	80	65	15	11	9
	1967	80	60	17	14	9
	1968	90	41	39	12	8
Central Ill.	1966	70	79	13	4	4
	1967	80	75	15	5	5
	1968	65	55	40	2	3
S. Ill.	1966	70	96	4	0	0
	1967	40	95	5	0	0
	1968	70	96	4	0	0
State average	1966	220	79	11	5	5
	1967	200	73	14	8	5
	1968	225	62	29	5	4

5. Western corn rootworm beetles were found in 58 of 225 fields on the random survey (Table 7).

Table 7. Random Survey of Western Corn Rootworm Distribution, 1968

District	County	No. fields surveyed	No. fields with WCR's
Northwest	Mercer	10	10
	Whiteside	10	9
	Stephenson	10	8
	Ogle	10	5
	Lee	10	4
West	Warren	10	10
	Henderson	10	8
	McDonough	5	3
Northeast	DeKalb	10	1
	Boone	10	0
	Kane	10	0
	LaSalle	10	0
East-central		40	0
West-southwest		30	0
East-southeast		40	0
Total		225	58

Table 8. Adult Corn Rootworm Populations, by Districts, Illinois, 1968

Average no. of beetles per plant	Percent of fields						Av.
	Northeast	Northwest	West	East-central	East-southeast	West-southwest	
0	0	3	0	0	43	67	22
0.1 to 1.0	33	28	40	44	54	26	38
1.1 to 3.0	43	49	60	48	3	7	31
3.1+	24	20	0	8	0	0	9

SUMMARY OF CORN ROOTWORM CONTROL DEMONSTRATIONS, 1968

H.B. PETTY, D.E. KUHLMAN, AND R.E. SECHRIEST

LOCATIONS AND COOPERATORS

Fourteen rootworm control demonstrations were planted in seven counties--Woodford, Warren, Lee, Ogle, Boone, DeKalb, and LaSalle, under the supervision of University of Illinois county Extension advisers, Mike Sager, James McCurdy, James Somers, Harold Brinkmeier, Stanley Eden, Wayne Hoelscher, Christian Scherer, George Swallow, Benjamin Greiner, Wallace Reynolds, Kenneth Bolen, Robert Curry, and Ronald Fink in cooperation with the following farmers--Murl Melton, James Tucker, Warren Faber, Francis Bybee, Lawrence Woessner, John Engelsen, John Huftalin, Walter Johnson, James Forster, Clarence Frey, Bruce Leman, and Marvin Pfister. Over 500 farmers, insecticide dealers, and chemical company representatives helped count rootworm larvae, dig plants, carry them from the field and wash them for damage rating. This is our opportunity to thank all of these fine cooperators.

Planting dates varied from April 25 to May 20, 1968, row widths varied from 30 to 40 inches, fertilizer programs varied, and hybrids, although the same in each field, varied from one field to another.

Insecticides were all applied at 1 pound per acre with a possible 10 percent variation. In 1968, BUXten, dasanit, diazinon, dyfonate, and phorate were recommended for resistant rootworm control and were used in these demonstrations. In addition, and since they were potential chemicals for 1969, Mocap and Furadan were included. Replicates varied in width from 8 to 32 rows. At the cooperators leisure (from June 3 to July 2) 1 pound of diazinon per acre was applied as a basal treatment to one-half of each replicate including the untreated. In most fields, each treatment was duplicated; in a few fields, aldrin was broadcast over the entire field prior to planting. In such instances, increase in larval control, stand, and yield was over and above the aldrin treatment.

Plant population counts were made in early June after plant emergence was complete; one two-hundredths of an acre was counted at each of 5 places in each replicate.

Larval counts were made from July 1 to July 16 by farmers who attended field meetings. Where the corn was hill-dropped, we dug hills of 2 or 3 plants depending upon the field average. If corn was drilled, we dug one plant. Six plants per replicate or 12 per field were examined for larvae for each insecticide in each field. The same is true for root ratings which were made in those fields that had enough larvae to anticipate root damage. These root ratings were made the week of July 22. The standard rating of 1 (clean) to 5 (all rings of roots destroyed) was employed. Results are recorded as larvae or rating per plant not per hill.

Two hundred and fifty plants per replicate were counted for lodging.

The plots were mechanically picked and the yields computed on the basis of Number 2 shelled corn.

RESULTS

For inclusion in this summary we have reasonably complete records on 8 fields (Table 4) and partial records on 4 more fields (Table 5) and insufficient records on 2 to include.

When larvae were counted in early July, Furadan and BUXten provided the best larval control and gave the best root protection (Table 1); dasanit, dyfonate, and phorate were next; and then diazinon. Larval counts and root ratings for Mocap planting time treatment did not coincide. Larval counts in Table 1 are slightly higher than those used in Tables 3 and 4. In one field the rootworm infestation occurred in only a part of the field. Records from this part of the field only were used to compute control. Yields were taken from the entire length of the field. So to correlate yield and larval populations (Tables 3 and 4), larval counts from the entire field were used.

Larval counts were made at varying intervals during July (Table 2). From these counts, one concludes that the basal application in June and the Furadan planting time application controlled rootworms throughout July, while the other insecticides began to show a decrease in effectiveness during July. This is shown in the average percent seasonal control. More of this type of information is needed.

We can compute the yield savings when rootworms are controlled or the expected increase in yield were rootworms to be controlled. Half of each planting time treatment (check and insecticides) received a basal application of diazinon. Thus yield differences between planting time treatments and the same planting time treatments plus basal treatment plots are due to rootworm control. We can correlate yield differences and larval populations (Table 3). Thus when there was a population of 2.5 larvae per plant in the check and 1.1 larvae per plant were controlled, the yield difference was 1.4 bushels or 1.1 percent, and the loss per larva per plant was 1.05 percent. Overall yield savings per larva per plant were 0.90 percent. If the population was 10 to 25 larvae per plant, the loss in yield for each larva per plant not killed was 0.85 percent.

To compute what a farmer's yield would have been, we can count the larvae per plant, multiply by the correct yield percent for the larval population present, and have the percent loss; then we can multiply by actual yield and have the bushel loss figure.

These larva counts were by some 500 farmers, dealers, etc., and are for use on the farm.

There is variation between fields because of hybrid, weather, fertility, and other factors. Field variations ranged from 0.4 to 1.28 percent loss per larva per plant. We need more years/data to obtain a more stable figure.

Root ratings and lodging apparently coincide to a reasonable degree with larval counts (Table 4). Correlation of rootworm populations and yield was complicated by plant stand variations between treatments. This variation in stand was probably due either to varying degrees of seed-infesting insect control or some chemicals depressed stands. We believe the stand difference is largely due to control of seed-infesting insects. Note that stands were highest in the diazinon plots, followed by those in dyfonate, dasanit, phorate and Furadan. The stands in the BUXten and possibly the Mocap plots were similar to the untreated.

With the moderate rootworm populations the value of seed protection by some insecticides offsets failures in rootworm control. Therefore to evaluate rootworm control and yields, it is necessary to adjust for stand. By using the values in Table 3 we can compute yield losses due to rootworms. The resulting differences are due to stand variations. We find that in these 8 fields it took 187 plants at 20,651 plants per acre to yield one bushel or 211 plants per 1 percent in yield. By adjusting to complete rootworm control and a stand of 21,500 plants per acre, the theoretical yield was 129.4 bushels per acre. Thus the savings when diazinon was applied at planting time was 6.2 bushels, dasanit 9.9 bushels, etc. Diazinon basal applications in June saved 8.3 bushels. However if you use basal treatments and certain planting time treatments to control rootworms, use something to protect the seed during germination.

The same general conclusions hold true when records for these 8 fields and the records for the additional 4 fields are combined (Table 5). Again, the stand in the diazinon plots was the highest; dyfonate was next, followed by dasanit, phorate, and Furadan. The BUXten stand was even slightly below the check plot. Diazinon rootworm control provided 5.6 bushels of corn above the check and the stand protection gave 2.7 bushels. Using dyfonate, rootworm control gave 7.1 bushels and the seed protection 1.3 bushels, Furadan 10.9 and 1.1, and dasanit 8.3 and 1.0. Thus, a value for stand protection and a value for rootworm protection can be assessed (Table 6). Average stand differences gave 1.6 bushels or 1.2 percent savings and rootworm 10.2 bushels or 7.9 percent. Infestations of rootworms ranged from light to moderate and seed insects from nothing to moderate.

CONCLUSIONS

1. In 1968, after a larval population was determined, we could add 0.9 percent per larva per plant to the yield to obtain a rootworm loss figure.

2. Basal applications of diazinon and Furadan planting time applications gave season control whereas the other insecticides seemed to become less effective in late July. Rainfall may have benefited the basal application.

3. Corn yields can be correlated with rootworm populations providing the effect of stand variation is eliminated between treatments.

4. In 1968, most insecticides applied at planting time gave practical control of moderate populations, but when populations were moderate to high, a division of insecticide effectiveness and performance was possible.

5. In an eight-field comparison in 1968, rootworm control saved 7.9 percent in yield and seed insect control 1.2 percent. These were moderate infestations; severe infestations could be devastating.

6. When the rootworm potential is severe, it is best to use the most effective insecticide and, if necessary, additional material for seed-insect control, either as a seed treatment or soil treatment.

7. For these reasons we recommend planting-time treatments of Furadan (if labeled), BUXten, dasanit, dyfonate, or phorate. For basal applications we recommend diazinon, disulfoton, phorate, parathion, or carbaryl for rootworm control.

Table 1. Summary of Rootworm Ratings (8 Fields)

Treatment		Larvae per plant	Root rating	Percent larva control	Percent root protection 1/
Furadan planting		1.2	1.48	92.3	84.8
" "	plus basal	1.1	1.29	92.8	90.8
BUXten planting		2.8	2.09	81.3	65.4
" "	plus basal	2.9	1.67	81.1	78.7
Dasanit planting		3.7	2.40	75.9	55.6
" "	plus basal	2.1	1.80	86.0	74.6
Dyfonate planting		4.6	2.42	69.4	54.9
" "	plus basal	3.0	1.99	80.5	68.6
Thimet planting		4.7	2.64	69.1	47.9
" "	plus basal	2.5	1.85	83.2	73.0
Mocap planting 2/		4.9	3.30	68.0	27.0
" "	plus basal 2/	2.4	1.88	83.9	72.1
Diazinon planting		6.6	2.86	57.4	41.0
" "	plus basal	3.6	2.20	76.3	61.9
Av. of:					
Check & Aldrin plots		15.2	4.15	...	...
" " " "	plus basal	5.2	2.26	65.6	60.0

1/ Based on a rating of 1.0 as no damage.
2/ Figures are based on 7 fields, not 8.

Table 2. Progressive Seasonal Percent Control of Rootworm Larvae

Treatment	Rate	Date of counts 1/ 7/1-10	7/15-25	7/29-8/8	Average percent control	Check 2/
Untreated 2/	..	14.1 (5)	18.1 (9)	12.5 (9)	...	15.0
			% control			
Diazinon basal	1.0	71.6 (5)	77.9 (9)	80.8 (9)	76.7	15.0
Diazinon planting	1.0	52.5 (5)	40.3 (8)	32.6 (8)	38.6	15.6
Dyfonate "	1.0	70.0 (3)	64.1 (5)	39.8 (5)	55.9	15.1
Phorate "	1.0	63.8 (5)	61.5 (7)	43.6 (8)	57.9	15.4
Dasanit "	1.0	71.4 (4)	67.1 (4)	58.3 (5)	65.7	16.3
BUXten "	1.0	83.3 (3)	91.5 (3)	61.3 (2)	83.8	16.9
Furadan "	1.0	100.0 (1)	88.5 (1)	89.9 (1)	89.9	15.1

1/ Parenthetical figures are number of comparisons. Each comparison represents a count of 4 plants.
2/ Average population per plant.

Table 3. Average Percent Yield Loss Per Rootworm Larva Per Plant

	Range in larvae per plant			
	0-5.0	5.1-10.0	10.1-25.0	Av.
No. of comparisons	37	18	11	66
Larvae per plant				
Check	2.5	7.1	16.2	6.1
Treated	1.4	3.8	5.9	2.8
Difference	1.1	3.3	10.3	3.3
Yields				
Check	122.8	122.5	110.0	120.6
Treated	124.2	126.0	118.7	123.8
Difference	1.4	3.5	8.7	3.2
% Savings	1.1	2.8	7.3	2.6
Loss per larva per plant				
Bushel	1.3	1.1	0.8	1.0
Percent	1.05	0.87	0.71	0.78
Increase per larva per plant over check				
Percent	1.06	0.90	0.77	0.80
Calculated yields if control had been complete				
Yield effect				
Bushel lost	1.8	5.0	6.4	3.6
Total yield	126.0	131.0	125.1	127.2
Increase per larva killed				
Bushel	1.28	1.12	0.93	1.08
Percent	1.04	0.91	0.85	0.90

Percent loss in yield per larva per plant by field

Warren Faber 0.41, Clarence Frey 0.62, John Engelson 0.51, Walter Johnson - James Forster 0.53, Murl Melton 1.24, James Tucker 1.28, Lawrence Woessner (early) 0.91, Lawrence Woessner (late) 0.53.

Table 4. Summary of Plant Populations, Larval Counts, Root Rating, Lodging, Actual Yields and Yields Corrected for Stand Variations for 8 Fields

Treatment	Plants per acre	Larvae per plant	Percent lodging					Yield, bu. per acre No. 2 corn	Yield in bu. per acre No. 2 corn corrected for stand[1/]
			Root rating	No. fields	Average larvae per plant	Angle and lean 30-60°	60-90°		
Check	20,651	15.0	4.2	6	14.9	17.6	13.8	111.4	111.4
Basal diazinon	20,651	5.3	2.3	5	5.2	4.0	0.2	119.7	119.7
Diazinon pl.	21,518	6.5	2.9	6	6.9	10.9	10.9	122.6	117.6
" plus basal	21,518	3.8	2.3	5	3.8	4.6	5.0	124.1	119.0
Phorate pl.	20,732	4.0	2.6	6	4.6	9.1	13.8	120.1	119.6
" plus basal	20,732	2.2	1.8	5	3.2	0.9	0.2	123.9	123.4
Dyfonate pl.	20,793	4.4	2.4	6	4.8	5.3	0.7	121.8	121.0
" plus basal	20,793	3.0	2.0	5	2.9	0.4	0	121.4	120.6
Dasanit pl.	20,927	3.6	2.4	6	3.7	8.4	2.5	122.9	121.3
" plus basal	20,927	2.1	1.9	5	1.9	1.4	0	126.8	125.2
BUXten pl.	20,518	2.7	2.1	6	3.1	4.4	0.3	120.8	121.5
" plus basal	20,518	2.8	1.7	5	2.8	0	0	122.5	123.2
Furadan pl.	20,876	1.1	1.5	6	1.0	2.6	0	125.8	124.0
" plus basal	20.876	1.1	1.3	5	1.1	0.6	0	125.8	124.5
Mocap pl.[2/]	20,742	4.9	3.3	5	5.1	12.6	13.6	120.2	120.0
Check[2/]	20,688	14.9	4.2	5	14.9	16.3	13.7	113.7	113.7

1/ 187 plants per bushel of corn or 211 plants per 1 percent in yield. Theoretically perfect yield at 21,500 stand is 129.4 bu. per acre.

2/ Only 7 fields.

Table 5. Summary of Plant Populations, Larval Counts, Actual Yields, and Yields Corrected for Stand Variations for 12 Fields

Treatment	Plants per acre	Larvae per plant	Yield in bu. per acre No. 2 shelled	Yield in bu. per acre No. 2 shelled corn for corrected stand1/
Check	21,148	10.6	118.5	118.5
Basal diazinon	21,148	3.6	125.6	125.6
Diazinon	21,901	4.6	126.8	124.1
Phorate	21,338	3.2	124.6	123.9
Dyfonate	21,518	3.2	126.9	125.6
Dasanit	21,429	2.5	127.8	126.8
BUXten	20,908	1.9	124.9	125.8
Furadan	21,379	0.8	130.3	129.4
Mocap2/	21,380	3.4	125.5	124.8
Check2/	21,217	10.1	120.7	120.7
Basal diazinon2/	21,217	3.6	127.3	127.3

1/ 330 plants per bushel of corn, or 352 plants per 1 percent in yield.
2/ Only 11 fields--246 plants per bushel.

Table 6. Calculated Bushels Per Acre and Percent Savings Due to Control of Moderate Rootworm Populations and Stand Differences in 8 Fields, 1968

Treatment	Rate per acre	Savings1/ Bushel Stand	Savings1/ Bushel Rootworm	Savings1/ Percent Stand	Savings1/ Percent Rootworm	Total
Basal diazinon	1	0	8.3	0	6.4	6.4
Diazinon pl.	1	5.0	6.2	3.9	4.8	8.7
" plus diazinon basal	1-1	5.1	7.6	3.9	5.9	9.8
Phorate pl.	1	0.5	8.2	0.4	6.0	6.7
" plus diazinon basal	1-1	0.5	12.0	0.4	8.9	9.7
Dyfonate pl.	1	0.8	9.6	0.6	7.4	8.0
" plus diazinon basal	1-1	0.8	9.2	0.6	7.1	7.7
Dasanit pl.	1	1.6	9.9	1.2	7.7	8.9
" plus diazinon basal	1-1	1.6	13.8	1.2	10.7	11.9
BUXten pl.	1	0.7	10.1	0.5	7.8	7.3
" plus diazinon basal	1-1	0.7	11.8	0.5	9.1	8.6
Furadan pl.	1	1.3	12.6	1.0	9.7	10.7
" plus diazinon basal	1-1	1.3	13.1	1.0	10.1	11.1

1/ Theoretical yield at a stand of 21,500 when all rootworms are controlled is 129.4 bushels per acre.

CORN ROOTWORM RESEARCH

RALPH E. SECHRIEST

Promising new insecticides and labeled insecticides for corn rootworm control were evaluated during 1968 at two locations in Illinois. Eleven insecticides were applied at planting time; twelve, as basal cultivator treatments (see Tables 1 and 2).

ALEDO & ROCHELLE

In the Aledo experiment, more differences were found in root damage ratings than in lodging and yield. Furadan, Bux, Landrin, and Mocap applied as planting-time treatments were not significantly different, by the root damage rating technique at Aledo. Furadan, Bux, Landrin, Dyfonate, Dasanit, Diazinon, and Niran were not significantly different as basal treatments. When considering the percent of lodged plants, all planting-time treatments and all but Di-Syston as basal treatments were significantly better than the untreated areas. Furadan at planting and basal and Bux at planting were the only treatments producing yields different from the untreated areas.

In the Rochelle experiment, only half of the planting-time treatments were different from the untreated. All of the basal treatments, except Mocap, were significantly different from the untreated. The basal cultivator treatments in both experiments appeared to give generally better and more-consistent control of the rootworm larvae.

At Aledo, the influence of soil pH as it affects the performance of the insecticides was also evaluated. The soil pH levels were approximately 5.3, 6.2, 7.0, and 7.6. No meaningful performance differences were observed that could be attributed to differences in soil pH.

PREPLANTING, PLANTING-TIME, & POSTEMERGENCE TREATMENTS

Mr. Eisenmayer, Henderson County Extension adviser in agriculture, Dr. Knake, and I examined the effect of combining herbicides, an insecticide, and a fertilizer in sprays applied broadcast to the soil as preplanting, planting-time, and postemergence treatments. Early results indicate that significant differences were found between treatments; also, that some differences can be found between times of application. The insecticide (Dyfonate) plots resulted in significantly less rootworm damage to the corn roots than those not receiving insecticide. The preplant broadcast insecticide treatments were better than the planting-time or postemergence treatments. The difference probably was due to more-thorough incorporation. Analysis of the yields indicated that herbicides were responsible for the greatest increase, with insecticides producing almost as great an increase. The effect of fertilizer was not as pronounced, since the fertility level was high prior to the experiment. Some interaction in yield differences was noted between the three factors. When herbicides were applied preplant, significantly better yields resulted. This study points out the need to utilize a complete program of fertility, weed control, and insect control to realize maximum yields.

Table 1. *Composite Data from Aledo Experiment Field*[a/]

Insecticide	Formu-lation	Lb. act./A.	Aledo root-damage rating P.T.	Aledo root-damage rating B.	Pct. lodging P.T.	Pct. lodging B.	Bu./A. P.T.	Bu./A. B.
Furadan	10G	1.0	1.28a[b/]	1.18a	11.06a	11.75a	149.7a	148.1a
Bux	10G	0.75	1.45a	1.46a	12.06a	14.06a	147.5a	139.3ax
Landrin (43-1)	15G	1.4	1.44a	...	18.94a	...	139.5ax	...
Landrin (43-1)	15G	0.75	1.78a	1.61a	20.19a	17.75a	136.5ax	141.0ax
Dyfonate	10G	1.0	1.92	1.71a	14.63a	14.81a	138.5ax	137.6ax
Dasanit	15G	0.75	1.99	1.85a	17.19a	16.69a	139.6ax	138.4ax
Thimet	15G	1.0	1.94	2.30	17.25a	20.75a	132.5ax	136.4ax
Mocap	10G	1.0	1.81a	1.94	13.81a	17.25a	138.4ax	136.4ax
Diazinon	14G	1.0	2.17	1.64a	22.56a	17.56a	135.1ax	140.7ax
Baygon	5G	0.5	...	2.21	...	21.31a	...	139.6ax
Sevin	20G	2.0	2.00	2.08	19.38a	24.06a	136.3ax	145.4ax
Di-Syston	15G	1.0	2.51x	2.42	29.25a	29.69ax	137.2ax	134.6ax
Niran	10G	1.0	2.53x	1.79a	20.13a	12.75a	139.0ax	143.3ax
Untreated	...	...	3.15x	...	49.75x	...	129.7x	...

a/ Planted (P.T.) on April 29, 1968; basal cultivator treatments (B.) applied June 5, 1968. Root damage ratings taken on July 16 and 17 (1 = no feeding). Lodging data were taken on August 26 and 27. Harvesting was done on October 16, 1968.

b/ Figures followed by the same letter are not significantly different at the 5-percent level.

Table 2. *Root-Damage Ratings from Rochelle and Average of Aledo and Rochelle*[a/]

Insecticide	Formu-lation	Lb. act./A.	Rochelle root-damage ratings P.T.	Rochelle root-damage ratings B.	Combined root-damage ratings, Rochelle + Aledo P.T.	Combined root-damage ratings, Rochelle + Aledo B.
Furadan	10G	1.0	1.22a[b/]	1.38a	1.25	1.28
Bux	10G	0.75	1.47a	1.44a	1.46	1.45
Landrin (42-1)	10G	0.75	1.50a	1.47a	1.64	1.56
Thimet	15G	0.5	...	2.04a	...	...
Thimet	15G	1.0	1.53a	1.75a	1.74	2.02
Baygon	5G	0.5	...	1.78a	...	1.99
Di-Syston	15G	1.0	1.41a	1.81a	1.96	2.12
Dasanit	15G	0.75	1.66a	1.57a	1.83	1.71
Dyfonate	10G	1.0	2.19x	1.91a	2.06	1.81
Diazinon	14G	0.5	...	1.63a	...	...
Diazinon	14G	1.0	2.28x	1.66a	2.23	1.65
Mocap	10G	1.0	2.76x	2.13	2.29	2.04
Sevin	20G	2.0	3.13x	2.03a	2.57	2.06
Niran	10G	1.0	3.21x	1.84a	2.87	1.91
Untreated	...	...	2.97x	...	3.06	...

a/ Rochelle: Planting-time treatments (P.T.) applied on April 26, 1968. Basal cultivator treatments (B.) applied on June 4, 1968. Ratings taken on July 18, 1968.

b/ Figures followed by same letter are not significantly different at 5-percent level.

A NEW SUBSURFACE TREATMENT

A new technique of applying soil insecticides has been tested during the last two growing seasons in cooperation with the Crop Chemical Testing Service. This subsurface treatment places insecticides in a band at a level below the soil surface. Improved control has been found with many insecticides when they have been placed subsurface. We hope this technique can be tested on other soil insects, in addition to corn rootworms.

ROOTWORM DAMAGE AND ROOT ROTTING OF CORN

WAYNE HOWE AND M.P. BRITTON

An investigation of the relationship between corn rootworm damage and root rotting in corn was begun in 1968. Fungi in the genera *Fusarium* and *Trichoderma* were isolated from rootworm channels in roots. The amount of *Fusarium* increased with the distance from the latest feeding site of the rootworm, and this fungus predominated in the rotted tissues. *Trichoderma* occurred mostly near the site of recent feeding.

PRODUCING NEW ROOTS

The ability of corn plants to survive rootworm damage appears to be related to the ability of the corn plant to produce new roots from the remains of the damaged ones. The roots arise from the outer portion of the stele (the central portion of the root containing vascular tissues). Our observations indicate that new roots can arise from exceedingly small portions of intact stele, even though rotting has destroyed the outer portion of the root.

COMMENTS

First-year tests with insecticide and fungicide applied to the soil prior to planting did not reduce the amount of root rotting. This study is to be continued for at least one more year.

ATRAZINE AS A POSTEMERGENCE SPRAY

F.W. SLIFE

The use of atrazine as a postemergence spray increased in Illinois during 1968. Apparently, the reason for this trend was the acceptable results in previous years and the attractiveness of waiting to use herbicides after the appearance of the weed problem.

Unfortunately, the 1968 results were not as spectacular as those in 1966 and 1967. In many cases, grass weeds were not controlled well. These field results are similar to the results on our experimental plots, and they indicate that all postemergence sprays are influenced greatly by environment. It would be difficult for us to conclude that preemergence treatments are more variable in terms of weed control than are the postemergence ones.

In addition to poor grass control in 1968, a few corn fields were injured by the postemergence treatment. Under the same conditions, 2,4-D applications produced some severe injury. It should also be pointed out that the postemergence applications of atrazine have the possibility of leaving more soil residue than preemergence treatments, even though they are usually used at lighter rates. The reason for this is that postemergence treatments may be applied much later than the preemergence ones, hence there is less opportunity for decomposition. Postemergence applications applied in late June, 1967, appeared to produce substantially more injury on soybeans in 1968 than preemergence applications applied a month earlier.

COMMENTS

In spite of the problems with the use of atrazine as a postemergence spray, it has been a remarkable treatment for many farmers, and they may prefer to continue to use it instead of preplant or preemergence treatments. Our research and observations would lead us to believe that preplant and preemergence treatments are more reliable and that atrazine plus additives should not be relied on as the main effort for weed control in corn.

ATRAZINE PLUS ADDITIVES

In our research program during 1968, different additives were compared with atrazine for postemergence activity. As in previous years, the various oils were slightly superior to surfactants. We did not see any major differences among the oils available for use with atrazine.

Our research program indicates that young grass weeds are the most sensitive to atrazine when moisture is available soon after application. Moisture after application increases leaf penetration; even more important, it moves some atrazine off of the leaves and puts it in position for absorption through the roots. We believe that root absorption is essential in order to kill grass weeds. It appears that heavy dews will produce enough moisture to aid leaf penetration and move atrazine off the leaf. Apparently, this appears to explain why we sometimes have only leaf burn on grasses; if this is not followed by cultivation, the grasses can recover. We believe that postemergence atrazine has been far more successful under wet conditions than dry; in addition, that application by air can be more successful than using ground equipment because the application can be made when the soil is wet. These wet conditions facilitate leaf adsorption and root uptake.

ATRAZINE AND BROADLEAVED WEEDS

One of the outstanding characteristics of atrazine applied either to the soil or postemergence is its effect on broadleaved weeds. In spite of the fact that atrazine has been variable for grass control applied as a postemergence treatment, it has shown consistent results when used on broadleaved weeds. Our results would indicate that 1 pound of atrazine or less with an additive is an effective treatment, and should be as reliable as 2,4-D with less risk of corn injury.

1969 Suggested Insecticide Guide

Insect Control for COMMERCIAL VEGETABLE CROPS and GREENHOUSE VEGETABLES

Commercial vegetable gardeners find it impossible to produce vegetables profitably unless they control insects at maximum efficiency and minimum cost. The housewife of today will not accept unsightly wormy vegetables; not only are wormy fruits and vegetables unappetizing but the waste from trimming increases food costs. Thus the commercial vegetable gardener must produce a quality product that is acceptable and safe to the consumer. Careful and correct use of the right insecticides will enable him to do this.

This suggested insecticide guide has been prepared for use by Illinois commercial vegetable farmers; it is not for home gardeners, who should use only those insecticides that are extremely safe to handle, apply, and store. Furthermore, the commercial vegetable gardener must use a wider variety of insecticides than the home gardener in order to obtain maximum insect control at the least cost.

In using insecticides, read the label and carefully follow the instructions. Do not exceed maximum rates suggested; observe carefully the interval between application and harvest, and apply only to crops for which use has been approved. Make a record of the product used, the trade name, the percentage content of the insecticide, the dilution, the rate of application per acre, and the date or dates of application.

Some of the insecticides suggested here can be poisonous to the applicator. In using them, the commercial gardener is expected to use precautions to protect himself, his workers, and his family from undue or needless exposure.

In using this guide, always refer to the table on the next page, which lists the limitations and restrictions on use. These limitations apply to the vegetables as human food. If you use any portion of a vegetable for livestock food (tops, stalks, etc.) refer to the label for instructions as to the interval required between application and feeding.

The chemical names used in these tables may be unfamiliar to you. These names are the common coined chemical names and as such are not capitalized. Trade names are capitalized. In the table of limitations the common names are listed first. If the trade name is more commonly used, it is listed in parentheses following the common name. Throughout the tables of suggestions, however, the common name is used if there is one. In case of question, refer to the table of limitations.

These suggestions are revised annually. Suggestions sometimes change during the growing season, thus they are subject to change without notification.

These suggestions were prepared by entomologists of the University of Illinois College of Agriculture and the Illinois Natural History Survey.

Leaflets describing the life history, biology, and habits of some of the insects mentioned can be obtained from the offices of county extension advisers or by writing to Office of Agricultural Publications, University of Illinois, Urbana, Illinois 61801. These are indicated by an NHE number in the tables.

Other circulars on insect control are:

Circular 898 — Insect Control for Livestock and Livestock Barns;
Circular 899 — Insect Control for Field Crops;
Circular 900 — Insect Control by the Homeowner;
Circular 936 — Pest Control in Commercial Fruit Plantings.

These can be obtained from the above offices or from the College of Agriculture, Urbana.

CIRCULAR 897 UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE
In cooperation with ILLINOIS NATURAL HISTORY SURVEY Urbana, Illinois, December, 1968

Cooperative Extension Work in Agriculture and Home Economics: University of Illinois, College of Agriculture, and the United States Department of Agriculture cooperating. JOHN B. CLAAR, *Director*. Acts approved by Congress May 8 and June 30, 1914.

LIMITATIONS FOR FIELD VEGETABLES IN DAYS BETWEEN APPLICATION AND HARVEST AND OTHER RESTRICTIONS ON USE OF INSECTICIDES IN ILLINOIS

(Blank spaces indicate the material is not suggested for the specific use in Illinois)

Insecticide	Asparagus	Beans	Broccoli	Brussels sprouts	Cabbage	Cauliflower	Horseradish[1]	Radish[1]	Turnip[1]	Onions	Eggplant	Tomatoes
azinphosmethyl (Guthion)[2]	...	...	15	7	21	15	...	...	...	...	...	...
carbaryl (Sevin)	1	0	3	3	3	3	3	3	3,14G	...	0	0
carbophenothion (Trithion)[2]	...	7A	...	...	...	...	...	...	...	...	7	7
Dasanit	...	...	...	...	...	...	...	...	...	I, J	...	...
diazinon	...	...	5	...	7	5	...	10	10	10	...	1
dimethoate (Cygon)	...	0C	7	...	3	7	...	...	14	...	...	7
endosulfan (Thiodan)	...	BC	7	...	7	B	...	...	...	...	1	1
ethion	...	...	...	...	...	...	...	...	...	I	...	...
dicofol (Kelthane)	...	7C	...	...	...	...	...	...	...	...	2	2
malathion	...	1	3	7	7	7	7	7	3	3	3	1
mevinphos (Phosdrin)[2]	...	...	1	3	1	3	...	...	3	...	...	...
naled (Dibrom)	...	...	1	1	1	1	...	...	4	...	...	...
parathion[2]	...	...	7	7	10	7	...	15	10	15	15	10
Perthane	...	...	3	3	3	3	...	...	...	...	...	...
phorate (Thimet)[2]	...	I	...	...	...	...	...	...	...	...	...	...
rotenone	1	...	...	...	...	...	...	...	...	...	1	1
toxaphene	...	...	...	B	7D	B	C	C	C	...	5	3
trichlorfon (Dylox)	...	...	...	21	21	21	...	...	28C	...	...	21

Insecticide	Potatoes[1]	Collards	Kale	Lettuce	Spinach	Swiss chard	Sweet corn	Cucumbers[3]	Melons[3]	Pumpkins[3]	Squash[3]	
											Winter	Summer
carbaryl (Sevin)	0	14	14	14	14	14	0	0	0	0	0	0
diazinon	...	10	10	10	10	12	I	7	3	...	3	7
dicofol (Kelthane)	...	...	...	...	...	...	...	2	2	2	2	2
dimethoate (Cygon)	7	14	14	14	14	14	...	...	7	...	...	...
dyfonate	...	...	...	...	...	...	I	...	...	...	...	...
endosulfan (Thiodan)	0	...	...	14H	...	...	...	...	...	...	...	...
malathion	0	7	7	14	7	7	5	1	1	3	1	1
mevinphos (Phosdrin)[2]	...	3	3	2	4	...	...	...	...	...	...	...
naled (Dibrom)	...	4	4	1	4	4	...	...	...	...	...	...
parathion[2]	5	10	10	21	14	21	12	15	7	10	15	15
Perthane	...	...	...	4	7	...	...	...	...	...	...	...
phorate (Thimet)[2]	I	...	...	...	...	...	...	...	...	...	...	...
rotenone	...	1	1	1	1	1	...	...	...	...	...	...
toxaphene	0	28	28	E	21F	E	B	B	B	B	B	B
trichlorfon (Dylox)	...	28B	21	28B	...	...	...	...	...	14F	...	...

[1] Root crops such as radishes, turnips, carrots, horseradish, potatoes, and sugar beets should not be grown in soil where aldrin, dieldrin, or heptachlor was applied as a soil insecticide the preceding year.
[2] To be used only by professional applicators or commercial gardeners.
[3] Only apply insecticide late in the day after blossoms have closed to reduce bee kill.

A. Not more than twice per season.
B. Not after edible portions or heads begin to form.
C. Do not use tops for feed or food.
D. If outer leaves are stripped; otherwise, B.
E. Do not apply after seedling stage.
F. Not more than once per season.
G. If tops are to be used as feed.
H. Not more than three times per season.
I. Soil applications at planting time only.
J. Do not use on green onion crop.

LIMITATIONS FOR GREENHOUSE VEGETABLES

Insecticide	Tomatoes	Lettuce
DDT	5 days	Do not use after seedling stage
endosulfan (Thiodan)	15 hours	...
malathion	15 hours	10 days
metaldehyde	As bait only applied to soil	
naled (Dibrom)	1 day	...
parathion[1]	10 days	21 days
tepp[1]	...	3 days

[1] Do not use aerosols that contain parathion, tepp, or the propellant methyl chloride in greenhouses connected to living quarters. Should be applied only by a trained operator.

CABBAGE AND RELATED COLE CROPS[1]

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Cabbage maggot[2] (NHE-44)	All season	diazinon	3	Broadcast	Disk in just before planting. Use only for cabbage, cauliflower, and broccoli.
		diazinon granules	1	Furrow	At time of planting; on turnips a drenching spray of 1 lb. diazinon should be applied 30 days following treatment.
		azinphosmethyl diazinon	3 oz. W.P. or 2 oz. E.C. per 50 gal. transplant water 4 oz. per 50 gal. transplant water		6 fluid oz. transplant water per plant.
Aphid (NHE-47)	All season	azinphosmethyl dimethoate malathion mevinphos parathion	¾ 0.3 1 ¼ 0.4	Foliage	When aphids appear, but before leaves begin to curl.
Diamond-back moth larva; imported cabbage worm; cabbage looper (NHE-45)	All season	azinphosmethyl endosulfan mevinphos naled parathion with toxaphene[3] Perthane with diazinon[3] Parathion with endosulfan[3]	¾ 1 ½ 1 ½ 2 1 ½ ½ 1	Foliage	When small worms first appear, and about every 5 to 7 days thereafter. Thorough spray coverage of foliage is important.
Cutworm	At planting	trichlorfon toxaphene	1 1½-2	Soil	At planting, at base of plant or as needed when damage first occurs.
Flea beetle and leafhopper	All season	carbaryl	1½	Foliage	As needed.

[1] Root crops such as radishes, turnips, carrots, potatoes, and sugar beets should not be grown in soil where aldrin, dieldrin, or heptachlor was applied as a soil insecticide the preceding year.

[2] Maggots are resistant to aldrin, dieldrin, and diazinon in some areas of Illinois.

[3] When using mixtures that have different "days between application and harvest" restrictions, choose the larger restriction.

Note: E.C. = emulsion concentrate; W.P. = wettable powder.

COLLARDS, KALE, LETTUCE, SPINACH, SWISS CHARD

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Aphid (NHE-47)	All season	diazinon dimethoate mevinphos naled parathion	½ 0.3 ¼ 1 0.4	Foliage	As needed.
Cutworm	On seedling plants	toxaphene trichlorfon	1½ 1	Base of plant and soil	When first damage appears.
Leafhopper	All season	carbaryl dimethoate malathion	1½ 0.3 1	Foliage	When first leafhoppers appear and as needed.
Caterpillar (NHE-45)	All season	mevinphos naled Perthane with diazinon or malathion[1] parathion with endosulfan[1]	½ 1 1 ½ 1 ½ 1	Foliage	When small worms first appear and every 5 to 7 days thereafter.
Leaf miner	All season	diazinon parathion	½ 0.4	Foliage	When first miners are observed.
Flea beetle	All season	carbaryl rotenone	1 ¼	Foliage	As needed.

[1] When using mixtures that have different "days between application and harvest" restrictions, choose the larger restriction.

BEANS

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Seed maggot (NHE-27)	All season	dieldrin[1] lindane[1]	Manufacturer's directions	Seed	At seeding.
		diazinon 50% W.P.[1]	3/5 oz./bu.	Seed	Treat seed no longer than 3 months before planting.
		phorate granules	1½	Soilband	Place on either or both sides of row at planting but not in contact with seed.
Bean leaf beetle (NHE-67)	Early and late season	carbaryl malathion	1 1	Foliage	When feeding first appears and weekly for 2 or 3 applications as needed.
Leafhopper (NHE-22) and plant bug (NHE-68)	All season	carbaryl dimethoate malathion	1 0.3 1	Foliage	Before plants become yellow and stunted. Repeat applications at weekly intervals as necessary.
		phorate granules	1½	Soilband	As for seed maggot.
Mexican bean beetle	Midseason and late season	carbaryl malathion	½ 1	Foliage	When occasional leaves show lacework feeding.
		phorate granules	1½	Soilband	As for seed maggot.
Aphid (NHE-47)	All season	dimethoate endosulfan malathion	0.3 ½ 1	Foliage	Usually applied when a few aphids can be found on each plant, but before leaves begin to curl and deform.
		phorate granules	1½	Soilband	As for seed maggot.
Blister beetle (NHE-72)	Midseason and late season	carbaryl	1½	Foliage	As needed.
Corn earworm (NHE-33)	Late season	carbaryl	1½	Foliage	As needed, but usually after September 1. Worms may be present before bloom.
Mites	Midseason and late season	carbophenothion dicofol dimethoate malathion	¾ 0.4 0.3 1	Foliage	As needed, but especially during drouthy periods particularly if carbaryl has been used on crops.
		phorate granules	1½	Soilband	As for seed maggot.

[1] No restrictions when used as recommended.

CUCUMBERS AND OTHER VINE CROPS[1]

Insect	Time of attack	Insecticide[2]	Lb. of active ingredient per acre	Placement	Timing of application[2]
Striped and spotted cucumber beetles (NHE-46)	Seedling to mature plants	carbaryl parathion	1 ½	Foliage	When beetles first appear; as often as necessary thereafter.
Aphid (NHE-47)	All season	diazinon dimethoate malathion parathion	½ 0.3 1 ½	Foliage	When aphids become noticeable.
Squash bug (NHE-51)	All season	parathion trichlorfon[3]	½ 1	Foliage	Do not apply until first eggs are found hatching (about June 15 to July 15).
Leafhopper	July-August	malathion dimethoate	1 0.3	Foliage	As needed.
Squash vine borer	June-September	carbaryl	1	Base of stem for 3 ft.	Weekly applications when vines begin to run—usually 5 applications.
Pickle worm	August-September	carbaryl	1	Foliage	Weekly applications, beginning in late August.
Mites	July-September	dicofol malathion parathion	½ 1 ½	Foliage	As needed.
Cutworm (NHE-77)	April-June	carbaryl toxaphene	2 1½-2	Base of plants	As needed.

[1] Pumpkins should not be grown on soil that has been treated with aldrin, dieldrin, or heptachlor the preceding year.
[2] Spray vine crops with insecticide only late in the day after blossoms have closed to reduce bee kill.
[3] Pumpkin is the only vine crop for which trichlorfon should be used for squash bug control. Apply only once per season.

TOMATOES AND EGGPLANT

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Cutworm (NHE-77)	Early and midseason	carbaryl toxaphene trichlorfon	2 3 1	Base of plants or foliage	As needed.
Flea beetle	May-June	carbaryl rotenone	2 0.2-0.4	Foliage	Apply every week as long as needed.
Aphid (NHE-47)	May-July	diazinon dimethoate endosulfan malathion parathion	¼ 0.3 ½ 1 0.4	Foliage	As needed, but before leaves curl.
Corn earworm	July-September; occasionally in June	carbaryl toxaphene	2 2	Foliage	Add to weekly applications of fungicide sprays beginning at first fruit set. If spraying is infrequent, use 6 lb. of toxaphene.
Hornworm	July-September	carbaryl trichlorfon	2 1	Foliage	When first small worms appear.
Mites	July-September	carbophenothion dicofol malathion parathion	1 ½ 1 0.4	Foliage	As needed.
Russet mite	July-September	parathion sulfur dust[1] sulfur spray[1]	0.4 10 10	Foliage	As needed.
Blister beetle (NHE-72)	June-September	carbaryl parathion toxaphene	1½ ¼ 2	Foliage	As needed.
Fruit fly and picnic beetle	August-October	diazinon spray diazinon granules	½ 1	Foliage	When flies or beetles first appear.
		pyrethrin dust[1]	1	Foliage	Apply to hamper immediately after it is filled.

[1] No limitations on use.

ASPARAGUS

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Asparagus beetle (NHE-49)	Early and mid-season on spears and ferns	carbaryl	1½	Spears and ferns	As needed, not oftener than every 3 days.
		rotenone	0.2-0.4	Spears	As needed.

SWEET CORN

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Soil insects (NHE-26, 27, 43)	April-August	diazinon dyfonate	1 1	Row	Apply on soil surface behind planter shoe and ahead of press wheel.
Cutworm (NHE-38)	April-June	carbaryl[1] toxaphene	2-3 3	Base of plants	When first damage appears. Use large quantities of water per acre.
Flea beetle (NHE-36)	April-July	carbaryl[1]	1½	Foliage	As necessary.
Japanese beetle (NHE-32)	July-September	carbaryl[1]	1	Ear zone	As necessary.
Corn borer	June-September	carbaryl spray, dust,[1] or granules diazinon granules	2 1½	Foliage	Make first application when tassel ratio is 30 to 40. Repeat every 4 to 5 days as long as field has 20 or more unhatched egg masses per 100 plants.
Corn earworm[1] (NHE-33)	June-September	carbaryl[1]	2	Ear zone	Market corn: At first silk and every 2 to 3 days for 5 to 8 applications. On very early or late planted corn, treatment may be necessary before silking when eggs are being laid on stalks and flag leaves. Canning corn: At 30 to 50% silk and every 3 days thereafter until corn is within 1 week of harvest.
Sap beetle (NHE-10)	July-September	carbaryl[1] diazinon malathion parathion	2 1 1 ½	Foliage	When adults first appear in field; usually between pollen-shedding and silk-drying.
Corn leaf aphid (NHE-29)	July-September	malathion	1	Foliage	As needed to produce attractive ears for fresh market.

[1] During pollen shed, apply carbaryl as late in the day as possible (preferably after 4 p.m.) to reduce bee kill.

ONIONS

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Onion maggot (NHE-50)	All season	diazinon W.P. ethion W.P.	½-1 for 40-50 lb. of seed 1 for 40-50 lb. of seed	Seed	Seed treatment for set onions only. Use lighter dosage of diazinon on sandy, highly mineral soils.
		Dasanit granules diazinon granules ethion granules	1 ½-1 ½-2	Furrow	Use 1 lb. active ingredient per acre for rows 12″ apart; ¾ lb. for rows 18″ apart; ½ lb. for rows 24″ apart. Up to twice these amounts are needed for ethion on muck soils. Do not use Dasanit on green onions.
		diazinon	2	Broadcast	Preplanting; disk into upper 1 to 2 inches of soil. Supplement with foliage spray below.
		diazinon malathion	⅓ 1	Foliage	Supplemental to soil treatment. Make first application when first adult flies are seen; make another 1 week later. From then on only as necessary.
Thrips (NHE-48)	Midseason and late season	diazinon parathion	½ ½	Foliage	When injury first appears and every 10 days as necessary.

POTATOES[1]

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Flea beetle	May-July	carbaryl endosulfan spray endosulfan dust	1 ½ 1	Foliage	When first damage appears on leaves, and repeat as needed.
Colorado potato beetle	May-July	carbaryl endosulfan spray endosulfan dust	1 ½ 1	Foliage	As needed.
Potato leafhopper (NHE-22)	May-July	carbaryl dimethoate endosulfan spray endosulfan dust	1 0.3 ½ 1	Foliage	Weekly applications when leafhoppers first appear
		phorate granules	2 to 3	Soilband	Place on either or both sides of row at planting but not in contact with seed. Use lower rate on sandy soils and heavier rate on heavy soils. Do not use on muck soils.
Aphid (NHE-47)	All season	dimethoate endosulfan spray endosulfan dust malathion parathion	0.3 ½ 1 1 ¼	Foliage	As needed.
		phorate granules	2 to 3	Soilband	As for leafhoppers.
Blister beetle (NHE-72)	All season	carbaryl toxaphene	1½ 2	Foliage	As needed.
Wireworm (NHE-43)	All season	phorate granules	2 to 3	Soil	Preplanting, disk in; or use as soilband at planting.
White grub (NHE-23)	All season	phorate granules	3	Soil	Preplanting, disk in; or use as soilband at planting.
Grasshopper (NHE-74)	July-September	carbaryl toxaphene	¾ 1½	Foliage	As needed, control in fence rows, roadsides, ditch banks, etc., before migration.

[1] Potatoes should not be grown in soil where aldrin, dieldrin, or heptachlor was applied as a soil insecticide the preceding year.

GREENHOUSE LETTUCE

Insect	Insecticide[1]	Dosage and formulation	Application
Aphid	malathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Garden fleahopper	parathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Mealybug Spider mite Whitefly	tepp aerosol	1 lb. 5% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Armyworm Cabbage looper	DDT dust	3% purified DDT dust, 20 lb. per acre	On soil surface; do not use after seedling stage.
Cutworm	malathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Sowbug	parathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Slug	metaldehyde	Commercially prepared bait or spray	To mulch on soil surface. Do not contaminate edible parts.

[1] See page 2 for limitations between application and harvest.

GREENHOUSE TOMATOES

Insect	Insecticide[1]	Dosage and formulation	Application
Aphid	endosulfan aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Whitefly	malathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
	naled vapor	5 oz. of 4% E.C. per 50,000 cu. ft.	Apply on steampipes.
	parathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Mealybug Spider mite Russet mite Thrip		Use malathion or parathion aerosol as suggested for aphid and whitefly.	
Armyworm Cabbage looper	DDT dust	3% purified DDT dust, 20 lb. per acre	On soil surface for cutworms; dust in air above plants for caterpillars.
Cutworm	malathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Tomato fruitworm	parathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Slug	metaldehyde	Commercially prepared bait or spray	To mulch on soil surface. Do not contaminate edible parts.

[1] See page 2 for limitations between application and harvest.

FOR YOUR PROTECTION

Always handle insecticides with respect. The persons most likely to suffer ill effects from insecticides are the applicator and his family. Accidents and careless, needless overexposure can be avoided. Here are a few easy rules that if followed will prevent most insecticide accidents:

1. Wear rubber gloves when handling insecticide concentrates.
2. Do not smoke while handling or using insecticides.
3. Keep your face turned to one side when opening insecticide containers.
4. Leave unused insecticides in their original containers with the labels on them.
5. Store insecticides out of reach of children, irresponsible persons, or animals; store preferably in a locked cabinet.
6. Wash out and then bury, burn, or haul to refuse dump all empty insecticide containers.
7. Do not put the water-supply hose directly into the spray tank.
8. Do not blow out clogged nozzles or spray lines with your mouth.
9. Wash with soap and water exposed parts of body and clothes contaminated with insecticide.
10. Do not leave puddles of spray on impervious surfaces.
11. Do not apply to fish-bearing or other water supplies.
12. Do not apply insecticides, except in an emergency, to areas with abundant wildlife or to blossoming crops visited by bees. Avoid drift onto blossoming crops or onto beehives.
13. Do not apply insecticides near dug wells or cisterns.
14. Do not spray when weather conditions favor drift.
15. Observe all precautions listed on the label.
16. To avoid bee kill, apply insecticides after bee activity has been completed for the day; use the least toxic materials. *Warn beekeepers that you are applying insecticides.*

1969 Suggested Insecticide Guide | Insect Control for LIVESTOCK AND LIVESTOCK BARNS

Livestock producers must follow a sound program of pest control if they are to attain maximum income for their farming investment. Flies, lice, mites, ticks, and grubs irritate animals and some of them suck their blood. This greatly reduces meat, egg, and milk production. On occasion, individual animals actually have been killed by attacks of large numbers of pests like horse flies, lice, and mites. Several of these pests can transmit diseases such as anaplasmosis and pinkeye from animal to animal. Thus losses from these pests each year cost Illinois farmers millions of dollars. A livestock producer does not need to share his profits with these insects. They can be readily controlled and in many cases eradicated.

In the following charts only the safest, most effective insecticides are suggested for each specific insect on each type of livestock. Other insecticides that may have label approval for use on livestock are not included because they are less effective or more toxic or present potential residue problems. Blank spaces in the table of limitations (back cover) mean that we do not suggest the insecticide for that specific purpose in Illinois.

In using insecticides read the label carefully and follow all instructions. Do not exceed the rates suggested; observe the interval between application and slaughter and apply only to those animals for which use has been approved. Keep a record of the insecticide used, the trade name, the percentage of active ingredients, the dilution, rate of application, and dates of application. If you are ever questioned, you have the records.

Most of the insecticides are suggested for use as emulsion concentrates since these are the easiest formulations to handle. However, wettable powders can be substituted for emulsion concentrates providing the finished spray is agitated.

The chemical names used in these tables may be unfamiliar to you. These names are the common coined chemical names and as such are not capitalized. Trade names are capitalized. In the table of limitations (back cover) the common names are listed first. Should the trade name be more commonly used, it is listed in parentheses with the common name. Throughout the tables of suggested insecticides on pages 2 and 3, however, only the common name is used where there is one. In case of question, refer to the table of limitations.

These suggestions are printed annually. Be sure you have the current year's issue. Suggestions sometimes change during the growing season, and so are subject to change without notification.

These suggestions were prepared by entomologists of the University of Illinois College of Agriculture and the Illinois Natural History Survey.

Fact sheets and Circular 925, Insect Pests of Cattle, describing the life history, biology, and habits of most of the insects mentioned, can be obtained from the offices of county extension advisers or by writing to Office of Publications, College of Agriculture, University of Illinois, Urbana, Illinois 61801. These fact sheets are indicated by an NHE number in the tables.

Other circulars on insect control are:

Circular 897 — Insect Control for Commercial Vegetable Crops and Greenhouse Vegetables;
Circular 899 — Insect Control for Field Crops;
Circular 900 — Insect Control by the Homeowner;
Circular 936 — Pest Control in Commercial Fruit Plantings.

These can be obtained from the same offices.

CIRCULAR 898 UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE
In cooperation with ILLINOIS NATURAL HISTORY SURVEY Urbana, Illinois. December, 1968

DAIRY CATTLE, BEEF CATTLE, SWINE, AND SHEEP

(Refer to table of limitations on back page before using insecticides)

	Insect	Insecticide	Amount per 100 gal. water or as directed	How to apply
Dairy Cattle	Lice and mange (NHE-18)	Ciodrin E.C., 4 lb. per gal. 3.2 lb. per gal. 2 lb. per gal.	1½ pt. 2 pt. 3 pt.	1–2 gal. per animal. Spray entire animal to saturation. Make 2 treatments 14 days apart.
Pastured cattle only	Horn flies (NHE-59) Stable flies (NHE-61)	Ciodrin 2.0% O.[1]		1–2 oz. per animal; 2–6 times per week.[2]
		dichlorvos 1.0% O.[1] pyrethrin 0.1% + synergist O.[1]		1–2 oz. per animal daily.[2]
	Horse flies (NHE-60)	pyrethrin 0.5% + synergist O.[1]		1–2 oz. per animal daily.[2]
		1% pyrethrin + synergist E.C.	10 gal.	1–2 qt. per animal every 3 days.[2]
	Face flies (NHE-106)	Ciodrin 2.0% O.[1]		1–2 oz. per animal, 2–6 times per week.[2]
	Grubs	rotenone 5% W.P.	7½ lb. + 1–2 lb. of detergent	2 gal. per animal monthly December through April.
		rotenone 1½% dust		3 oz. per animal monthly December through April. Rub vigorously over affected areas.
Beef Cattle	Lice and mange (NHE-18)	lindane 20% E.C. lindane 12.4% E.C. malathion 50–57% E.C.	1½ pt. 1 qt. 3 qt.	1–2 gal. per animal. Spray entire animal to saturation. Make 2 applications 14 days apart.
Pastured cattle only	Horn flies (NHE-59) Stable flies (NHE-61)	Ciodrin 2.0% O.		1–2 oz. per animal; 2–6 times per week from automatic sprayer.[2]
		toxaphene 60% E.C.	5 pt.	1–2 qt. per animal every 3 weeks. Only partially controls stable flies.[2]
	Horse flies (NHE-60)	Use as directed for dairy cattle above.		
	Face flies (NHE-106)	Ciodrin 2.0% O.		As for stable flies.
		Ciodrin E.C. 4 lb. per gal. 3.2 lb. per gal. 2 lb. per gal.	2 gal. 2½ gal. 4 gal.	1 qt. per adult animal per week.[2]
		toxaphene 5% O.		Saturate cloth, canvas, or burlap head or back oiler at least weekly. Also controls horn flies and helps prevent buildup of lice in winter.
	Grubs	rotenone 5% W.P. rotenone 1½% dust	As for dairy cattle	
		The following systemic insecticides, coumaphos, crufomate, and trichlorfon, as sprays provide excellent control of grubs and good control of lice. Use only on *native beef cattle;* apply during August or September in the southern half of the state and in September or October in the northern half of the state. Grub control in Illinois is seldom profitable for the farmer.		
Swine	Mange and lice	lindane 20% E.C. lindane 12.4% E.C. malathion 50–57% E.C.	1 qt. 3 pt. 3 qt.	1–2 qt. per animal. Spray entire animal to saturation. Make 2 applications 14 days apart.
Sheep	Ticks, lice, and scab (NHE-53)	lindane 20% E.C. lindane 12.4% E.C.	1 qt. 3 pt.	Spray entire animal to saturation. Use ½ strength in dipping vat for scab.
		toxaphene 60% E.C.	3 qt.	Spray entire animal to saturation or use in dipping vat for scab.
	Nose bot	crufomate 21% E.C.		Administer 2 cc. per 10 lb. of body weight as a drench.

Note: E.C. = emulsion concentrate, O. = oil solution, W.P. = wettable powder.

[1] The same dosage of a water-base spray may be used, but control is generally less effective.

[2] Spray head, back, sides, belly, and legs carefully. Start treatments in June.

Cooperative Extension Work, University of Illinois, College of Agriculture, and the U.S. Department of Agriculture cooperating.
JOHN B. CLAAR, *Director*. Acts approved by Congress May 8 and June 30, 1914. (20M—12-68—99104—O-1352)

CHICKENS, BARNS, AND SHEDS

(Refer to table of limitations on back page before using insecticides)

	Insect	Insecticide	Amount per 100 gal. water or as directed	How to apply
Chickens	Common red mites, bedbugs, and lice (NHE-54)	carbaryl 80% W.P. (not for lice)	4 oz. per 5 gal. water	Spray roosts, back walls, side walls, and around nests.
		coumaphos 25% W.P.	6 oz. per 5 gal. water	Spray roosts, back walls, side walls, and nests.
		malathion 50–57% E.C.	10 oz. per 5 gal. water	
	Northern fowl mites and lice (NHE-54)	carbaryl 5% dust		Apply to litter, 1 lb. per 40 sq. ft., and 1 lb. per 100 male birds.[1]
		coumaphos 0.5% dust		Apply to litter and nests, 1 lb. per 20 sq. ft.; 1 lb. per 100 male birds.[1]
		malathion 4% dust		Apply to litter and nests, 1 lb. per 50 sq. ft.; 1 lb. per 100 male birds.[1]
	Northern fowl mites, common red mites, bedbugs, and lice (NHE-54)	carbaryl 80% W.P.	4 oz. per 5 gal. water	Spray birds and roosting areas (1 gal. per 100 birds). Use in caged laying operations or when litter is sparse or wet.
		coumaphos 25% W.P.	3 oz. per 5 gal. water	Spray birds, nests and roosting areas (1 gal. per 100 birds). Use in caged laying operations or when litter is sparse or wet.
		malathion 50–57% E.C.	5 oz. per 5 gal. water	
Residual Sprays for Barns and Sheds	House flies (NHE-16, 88) Stable flies (NHE-61)	fenthion 46% E.C. (beef barns only)	3 gal.	Start treatments in June and maintain good sanitation. Apply 2 gal. per 1000 sq. ft. or to runoff to ceilings, walls, and support posts, and outside around doors and windows. Every 4–6 weeks during fly season.[2]
		fenthion 25% W.P. (beef barns only)	48 lb.	
		diazinon 50% W.P.	16 lb.	Treat every 2–4 weeks during fly season.[2] Otherwise apply as for fenthion.
		dimethoate 25% E.C.	4 gal.	Treat every 4–6 weeks during fly season.[2] Otherwise apply as for fenthion.
		Rabon 25% E.C.	4 gal.	
		ronnel 24% E.C.	4 gal.	Treat every 1–3 weeks during fly season.[2] Otherwise apply as for fenthion.
		ronnel 25% W.P.	32 lb.	
Baits as Supplements for Barn and Shed Sprays	House flies (NHE-16, 88)	diazinon E.C. trichlorfon E.C.	Dilute to 0.1% mixture in 2 parts corn sirup and 1 part water	Apply to favorite fly-roosting areas from tank sprayer as needed to supplement residual spray treatment.
		dichlorvos E.C. naled E.C.	Dilute to 0.1%–0.5% in 2 parts corn sirup and 1 part water	Apply as for diazinon and trichlorfon.
		ronnel E.C.	Dilute to 2% in 2 parts corn sirup and 1 part water	Apply as for diazinon and trichlorfon.
		Dimetilan 4% bands		Hang 1 band per 75 sq. ft. of area from the ceiling or support posts. A supplement to residual sprays.

Note: E.C. = emulsion concentrate, O. = oil solution, W.P. = wettable powder.

[1] The male birds will not require dusting for the control of lice.

[2] Lasting effects are shortened during periods of hot, dry weather.

LIMITATIONS FOR SUGGESTED INSECTICIDES APPLIED TO LIVESTOCK OR IN LIVESTOCK BARNS

(Blank spaces in the table denote that the material is not suggested for that specific use in Illinois)

	Dairy		Beef		Swine		Sheep		Chickens	
	Animals	Barns	Animals	Barns	Animals	Barns	Animals	Barns	Birds	Barns
carbaryl (Sevin)	...	...	...	...	...	...	...	...	E, I	E, I
Ciodrin	B	...	B	...	...	...	...	...	...	...
coumaphos (Coral)	...	...	B, D	...	...	...	...	...	I, J	I, J
crufomate (Ruelene)	...	...	B, A	...	...	...	B, L, N	...	...	...
diazinon	...	H, C	...	H, C	...	H, C	...	H, C	...	H, C
dichlorvos (DDVP) (Vapona)	B	C	...	C	...	C	...	C	...	C
dimethoate (Cygon)	...	H	...	H	...	H	...	H	...	H
Dimetilan	...	C, M	...	C, M	...	C, M	...	C, M	...	C, M
fenthion (Baytex)	...	...	...	H	...	...	...	...	...	...
lindane	...	...	B, G, K	...	B, G, K	...	B, G	...	...	...
malathion	...	...	B	...	B	...	...	...	I	I
naled (Dibrom)	...	C	...	C	...	C	...	C	...	C
pyrethrin	B	...	B	...	...	...	...	...	...	...
Rabon	...	H	...	H	...	H	...	H	...	H
rotenone	B	...	B	...	...	...	...	...	...	...
ronnel (Korlan)	...	H, C	...	H, C	...	H, C	...	H, C	...	I
toxaphene	...	...	B, F, K	...	...	...	B, F	...	...	...
trichlorfon (Dipterex) (Neguvon)	...	C	B, D, L	C	...	C	...	C	...	C

A. Do not apply within 28 days of slaughter. Do not apply repeat applications within 28 days. Do not treat after November 1. Do not treat sick animals. Give animals free access to water and feed before and after treatment.
B. Do not contaminate feed, water, milk, or milking utensils.
C. As a bait. Do not apply within reach of animals or in milkrooms. Do not contaminate feed, water, milk, or milking utensils.
D. Do not treat animals less than 4 months old, sick or convalescent animals, or stressed animals. Do not treat for 10 days before or after shipping. Do not apply in conjunction with internal medications or with pyrethrins, allethrin or their synergist, or with organic phosphates. Do not apply in poorly ventilated areas.
E. Do not apply within 7 days of slaughter and do not treat nesting material. Do not repeat within 4 weeks.
F. Do not apply within 28 days of slaughter.
G. Do not spray within 30 days of slaughter. Do not dip within 60 days of slaughter.
H. When used as a spray, remove animals before treating barn and cover feed and watering troughs. Do not use in milkrooms. Do not apply to animals.
I. Gather eggs before treatment and do not contaminate feed and water.
J. Do not apply within 10 days of vaccination or other stress influences. Do not apply more often than once a week.
K. Do not treat cattle less than 4 months old or pigs before weaning.
L. Do not apply within 14 days of slaughter.
M. Do not apply above feed, water, or milking utensils.
N. Do not drench sick, weak, or overheated animals; lambs under 30 pounds; animals being fed in confinement; or pregnant animals within one month of lambing.

FOR YOUR PROTECTION

Here are a few easy rules that if followed will prevent most insecticide accidents:

1. Wear rubber gloves when handling insecticide concentrates.
2. Do not smoke while handling or using insecticides.
3. Keep your face turned to one side when opening insecticide containers.
4. Leave unused insecticides in their original containers with the labels on them.
5. Store insecticides out of reach of children, irresponsible persons, or animals; store preferably in a locked cabinet or room.
6. Wash out and bury or burn empty insecticide containers.
7. Do not put the water-supply hose directly into the spray tank.
8. Do not blow out clogged nozzles or spray lines with your mouth.
9. Wash with soap and water exposed parts of body and clothes contaminated with insecticide.
10. Do not leave puddles of spray on impervious surfaces.
11. Do not apply to fish-bearing or other water supplies. Do not allow treated animals in fish-bearing waters or other water supplies until the spray has dried.
12. Do not apply insecticides, except in an emergency, to areas with abundant wildlife or to blossoming crops visited by bees. Avoid drift onto blossoming crops and onto beehives.
13. Do not apply insecticides near dug wells or cisterns.
14. Do not spray when weather conditions favor drift.
15. Observe all precautions listed on the label.

1969 Suggested Insecticide Guides

Insect Control for FIELD CROPS

Insects and related pests play a major role in field crop production in Illinois. Although normal agronomic practices developed during the past century have reduced the importance of many insect pests, chinch bugs, grasshoppers, armyworms, aphids, white grubs, wireworms, cutworms, and many other native insects have continued to be threats to grain and forage production. These native insects have been joined by such aliens as the European corn borer, Japanese beetle, alfalfa weevil, spotted alfalfa aphid, southwestern corn borer, sweet clover weevil, and others. Without the use of the modern insecticides, these insects would seriously hamper economical production by Illinois farmers and harvests would be much less bountiful. Weather variations from year to year greatly affect insect populations, but annually Illinois farmers reap more than 30 million dollars profit from the use of insecticides to control field crop insects.

Financial gain from use of insecticides has not been the only compensation. Use of modern insecticides reduces stalk breakage and lodging from insect damage. This possibly has reduced the incidence of clogged pickers and accidents. Proper use of insecticides has also greatly reduced the need for replanting. Thus proper use of insecticides is an integral part of our farming business.

However, those using insecticides should apply all the scientific knowledge available to insure that there will be no illegal residue on the marketed crop. Such knowledge is condensed on the label. Read it carefully and follow the instructions. But the label should be recent and not from a container several years old. Do not exceed maximum rates suggested; observe carefully the interval between application and harvest; and apply only to crops for which use has been approved. Make a record of the product used, the trade name, the percentage content of the insecticide, dilution, rate of application per acre, and the date or dates of application.

Some of the insecticides suggested in this publication can be poisonous to the applicator. The farmer is expected to protect himself, his workers, and his family from undue or needless exposure.

The chemical names used in these tables may be unfamiliar to you. These names are the common coined chemical names and as such are not capitalized. Trade names are capitalized. In the table of limitations the common names are listed first. Should the trade name be more commonly used, it is in parentheses following the common name. Throughout the tables of suggestions, however, the common name is used if there is one. In case of question, refer to the table of limitations.

Descriptions of specific insects, their life history, biology, and cultural control methods are available. These are designated in the tables with NHE numbers, and can be obtained from the county extension adviser or by writing to Office of Agricultural Publications, University of Illinois, Urbana, Illinois 61801.

Other circulars on insect control are:

Circular 897 — Insect Control for Commercial Vegetable Crops and Greenhouse Vegetables;

Circular 898 — Insect Control for Livestock and Livestock Barns;

Circular 900 — Insect Control by the Homeowner;

Circular 936 — Pest Control in Commercial Fruit Plantings.

These suggestions are revised annually by entomologists of the College of Agriculture and the Illinois Natural History Survey.

Suggestions sometimes change during the growing season and thus are subject to change without notification.

CIRCULAR 899 UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE
In cooperation with ILLINOIS NATURAL HISTORY SURVEY Urbana, Illinois, December, 1968

SPECIAL SUGGESTIONS AND MAJOR CHANGES FOR 1969

Changes in Suggestions During 1969

Use of chemicals on Illinois farms has been of great benefit to production, but along with this use has gone the added responsibility of producing food without illegal residues. The record of the Illinois farmer has been good, but to maintain this record, he must keep abreast of the latest information.

Tolerances for old products may be changed, or new insecticides may receive federal label approval. Consult your University of Illinois county extension adviser for changes made during the year.

Illinois entomologists review all data available and limit the list of insecticides to those that best fit farms in Illinois. Thus, there are other materials labeled for use, but not listed in this circular.

Dairy Farms

As in the past, dairy farmers are cautioned against the use of the chlorinated hydrocarbon insecticides, aldrin, chlordane, dieldrin, DDT, endrin, heptachlor, or lindane on their farms to avoid the possibilities of illegal residues in milk.

Because of possible drift, do not apply sprays or dusts of aldrin, DDT, chlordane, dieldrin, heptachlor, or lindane to fields adjacent to dairy hay, pasture, or ensilage crops.

Soybean Farms

1. *Do not use* the soil insecticides aldrin, chlordane, dieldrin, endrin, heptachlor, or lindane as a soil or foliar treatment for soybeans.
2. At present, if either aldrin or heptachlor has been applied annually in a field for five or more years, allow two years to elapse from the date of the last application before planting soybeans. Thus, if aldrin or heptachlor was applied to a field from 1964 through 1968, do not apply aldrin or heptachlor in 1969, and do not grow soybeans in this field until 1970. If corn is grown, use one of the suggestions for rootworms listed below.
3. For the common Illinois rotation (which includes soybeans, corn, and grains), continue to plant soybeans as you have in the past. The future of this suggestion depends on research and survey data.

Corn Soil Insect Situation

In 1968 *western corn rootworms* were found throughout the area of Illinois north of a line from Pittsfield (Pike County) to Lincoln (Logan County) to Kankakee (Kankakee County) with the exception of eight counties, and in 1969 they may spread to most counties north of a line from St. Louis to Danville. In Mercer and adjoining counties, many second-year cornfields were damaged in 1968. In 1969 many fields of second-year corn north and west of a line from Dixon to Peoria to Stronghurst (Highway 116) and extended to the state boundaries will be severely damaged. Some second-year cornfields will be damaged more than others, although not all of them will be severely affected. Some fields of second-year corn will be damaged east and north of this line.

Aldrin and heptachlor will no longer control western corn rootworms.

The *northern corn rootworm* is most abundant north of Highway 36 (Pittsfield to Springfield to Decatur) and is often a pest in fields if corn is grown for three or more years continuously in the same field. Under some conditions, we have seen second-year corn damaged by northern corn rootworms.

Although northern rootworms are not a general pest south of this line, they do damage corn severely in certain localized areas, such as bottomland, where corn is grown as a continuous crop.

Northern corn rootworm populations increased in 1968. Despite this increase in numbers, weather conditions favored root regrowth and many fields were able to recuperate from severe root pruning and produce a good yield. Therefore, damage was less apparent in 1968 than in 1967. Corn rootworm beetle populations were greater in August of 1968 than in 1966 or 1967. Therefore, the threat of damage is greater for 1969. To further complicate matters for 1969, resistance to aldrin and heptachlor has increased to such a degree that these two insecticides no longer give practical control of the northern corn rootworms in the majority of cornfields.

Seed-corn beetles eat the seed and chew off the sprout during germination. This past year these pests were very abundant; aldrin, dieldrin, heptachlor, and lindane soil or seed treatments commonly failed to control them. *Seed-corn maggots* hollow the seeds prior to their germination. In at least two instances, resistance to aldrin, chlordane, dieldrin, heptachlor, and lindane was confirmed.

Combinations of attack by these two seed pests in 1968 reduced stands from a few hundred plants per acre in some fields to as many as several thousand plants in others.

Wireworms, cutworms, white grubs, grape colaspis and others are still controlled by the use of aldrin or heptachlor, even though they no longer can be relied upon to control rootworms, seed-corn beetles, and seed-corn maggots.

Control of Resistant Rootworms, Resistant Seed Insects, and Garden Symphylans

A crop rotation may be the easiest method for control of *resistant corn rootworms*. To hold populations of northern corn rootworms at low levels, do not grow corn for more than two years successively in any rotation. In western corn rootworm areas, rotations involving only one year of corn may be required. However, the resistant strain of northern corn rootworms may become a problem on second-year corn as the western corn rootworms are.

In addition to crop rotation, early planting may help to minimize root damage by corn rootworm larvae and pollination damage by the adults, but may increase corn borer problems.

Although several insecticides are labeled for corn rootworm control, entomologists of the University of Illinois Cooperative Extension Service and the Illinois Natural History Survey suggest the following materials for most effective rootworm control in Illinois. These rates are based on row length, not width.

For planting application

Furadan (if label approval is granted)	1 pound per acre
BUX ten	1 pound per acre
Dasanit	1 pound per acre
Dyfonate	1 pound per acre
Phorate	1 pound per acre

These materials were used in Illinois in 1968 at the rates listed. To reduce costs, lower rates of application have been suggested. Lower rates will probably reduce effectiveness, however, particularly with heavy infestations.

For basal application in June

Diazinon	1 pound per acre
Disulfoton	1 pound per acre
Parathion	1 pound per acre
Phorate	1 pound per acre
Carbaryl	2 pounds per acre

When applied at *planting time,* many of the registered organic-phosphate insecticides and carbamate insecticides kill only 40 to 75 percent of the rootworms. With light infestations of corn rootworms this is practical control and, although not as effective on early planted corn as on later planted corn, they still did an acceptable job in Illinois in 1968. However, in fields with moderate-to-heavy infestations the more effective insecticides are needed to give a practical degree of control.

Applications of insecticides approved for use during *cultivation* in late May to mid-June are equally effective. The insecticide is directed at the base of the plant and for best results should be covered with some soil. These basal applications can be made when it is convenient, but to avoid bad weather, do not wait until the last minute.

The effectiveness of insecticides listed for rootworm control at planting may be adversely affected by heavy rainfall. Control of corn rootworm may be less effective when insecticides are applied to early planted corn than to later planted corn because of exposure to greater amounts of rainfall.

Extreme drought conditions may also decrease effectiveness of the insecticide. This could be particularly important in the use of basal applications to control rootworms. For this reason, late May to mid-June applications are encouraged to take advantage of normal rainfall patterns.

Resistant seed-corn beetles and maggots were controlled by planting applications of Dasanit, diazinon, dyfonate, Furadan, and phorate. We have no data on seed beetle control by the use of planter applications of carbaryl, disulfoton, and parathion.

An experimental application of 3 ounces of 50-percent diazinon wettable powder (1½ ounces actual) plus 1½ ounces of graphite per bushel of seed just prior to planting gave excellent *seed-corn beetle* control in a few fields in central Illinois. Resistant *seed-corn maggots* have been controlled with as little as ½ ounce of diazinon per bushel of seed in Canada. The rate of diazinon to be used per bushel of seed has not been thoroughly established for seed-corn beetle and seed-corn maggot control in Illinois. It is entirely possible that 1 ounce per bushel of the actual diazinon may provide excellent control.

If combinations of diazinon and other insecticides are used as seed treatments, follow the manufacturer's directions to avoid possible germination injury. In using a seed treatment, empty and clean the planter often to avoid accumulation of excess powder in the bottom of the planter box, which could interfere with seeding rates.

To further confuse the soil insect problem in Illinois cornfields, the *garden symphylan,* a tiny, white, rapidly moving, centipede-like pest, has appeared in many Illinois cornfields where it feeds upon corn roots. Small areas in fields may be generally stunted, or in other areas one plant may be knee-high while an adjoining plant may be shoulder-high. These stunted plants do not produce normally. Of the insecticides mentioned for rootworm control, only dyfonate seems to be effective in the control of this pest. Zinophos and parathion have been reported by some states as an effective control.

Condensed Soil Insecticide Suggestions

In 1969, suggestions for maximum soil insect control in Illinois cornfields must be based on individual situations. We have attempted to list them below.

1. First-year corn, or any corn in areas where rootworms are no problem:

On non-dairy farms: Use diazinon as a seed treatment to control resistant seed-corn beetles and seed-corn maggots. If cutworms, wireworms, white grubs, grape colaspis and others are usually a problem, broadcast and disk in 1½ pounds of aldrin or heptachlor per acre prior to planting. Row treatments of 1 pound per acre can be used but will be less effective.

On dairy farms: If soil insects have been a problem, apply 1 to 1½ pounds of diazinon, or 1 pound of Dasanit, dyfonate, or phorate at planting time in a 7-inch band to the surface of the soil ahead of the press wheel. If you do not do this, at least as a minimum, use a diazinon seed-treatment. If you suspect that garden symphylans are present, use dyfonate at planting time.

2. Fields in corn for two or more years in the area of severe western corn rootworm infestations (west and north of a line from Dixon to Peoria to Stronghurst):

Use Furadan (if labeled), BUX ten, Dasanit, dyfonate, or phorate at one pound per acre at planting time, or apply 1 pound of diazinon, disulfoton, parathion, or phorate, or 2 pounds of carbaryl as a basal application. When using Buxten at planting or any basal application with no planting time application, use a diazinon seed treatment at planting time.

3. Fields in corn for three or more years in the area where western rootworms are not a problem and northern corn rootworms are:

Apply the same controls that are listed in Section 2.

LIMITATIONS IN DAYS BETWEEN APPLICATION OF THE INSECTICIDE AND HARVEST OF THE CROP AND OTHER RESTRICTIONS ON THE USE OF INSECTICIDES FOR FIELD CROP INSECT CONTROL

(Blanks in the table denote that the material is not suggested for that specific use in Illinois)

	Field corn				Forage crops			
	Seed and soil	Grain	Ensilage	Stover	Alfalfa	Clover	Pasture	Seed
aldrin	A	...	...	...	...	...	...	...
azinphosmethyl (Guthion)[1]	...	...	...	...	16,E	16,E	...	16,E
BUX ten (0-5353)[1]	A	I	I	I	...	...	...	...
carbaryl (Sevin)	...	0	0	0	0	0	0	...
dasanit	A	I	I	I	...	...	...	...
demeton (Systox)[1]	...	...	...	...	21,E	21,E	21,E	21,E
diazinon	A	7	10	10	7	7	K,L	7
disulfoton (Di-Syston)[1]	100,J	100,J	100,J	100,J	...	...	...	...
dyfonate[1]	A	I	I	I	...	...	...	...
Gardona	...	A	...	...	...	...	...	...
heptachlor	A	...	...	...	...	...	...	...
malathion	...	5	5	5	0	0	0	0
methoxychlor	...	...	...	...	7	7	7	7
naled (Dibrom)	...	...	...	...	4	4	4	4
methyl-parathion[1]	...	12	12	12	15	15	15	15
parathion[1]	...	12	12	12	...	...	...	...
phorate (Thimet)[1]	A	B	B	B	...	...	...	...
toxaphene	...	A	C	C	...	...	...	D
trichlorfon (Dylox)	...	40,M	40,M	40,M	...	...	...	...

	Barley		Oats		Rye		Wheat		Soybeans	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Forage
azinphosmethyl (Guthion)[1]	...	...	...	...	...	...	...	...	21	D
carbaryl (Sevin)	F	F	F	F	F	F	F	F	0	0
carbophenothion (Trithion)[1]	...	...	...	...	...	...	...	...	7	D
demeton (Systox)[1]	45,G	21,G	45,G	21,G	...	...	45,G	21,G	...	...
disulfoton (Di-Syston)[1]	...	...	...	...	...	...	...	H	...	...
malathion	...	...	...	...	...	...	...	...	3	1
parathion[1]	15	15	15	15	...	...	15	15	...	...
phorate (Thimet)[1]	...	...	...	...	...	...	...	H	...	...
toxaphene	A	D	A	D	A	D	A	D	21	D
trichlorfon (Dylox)	21	D	21	D	...	...	21	D	...	...

1. Except as granules, to be applied only by experienced operators wearing proper protective clothing.
A. No specific restriction when used as recommended.
B. Do not apply after tassel emergence.
C. Do not feed treated forage to dairy animals. Do not feed sprayed forage or granular-treated corn silage to livestock fattening for slaughter nor granular-treated stover within 28 days of slaughter.
D. Do not feed treated forage to dairy animals, livestock fattening for slaughter, or poultry.
E. Once per cutting.
F. Not after boot stage.
G. Apply no more than twice per season with at least 14 days between applications.
H. Do not graze treated wheat.
I. Does not have label approval.
J. Do not apply more than once per season regardless of method of application.
K. Livestock may be grazed immediately following application or may be fed green forage immediately following cutting.
L. If grass pastures are to be cut for hay, allow 21 days between application of water solution or 30 days for oil solution.
M. Once only per season when plants are 3-12 inches tall.

FIELD CORN

Insects	Time of attack	Insecticide[1]	Lb. active ingredient per acre	Placement	Timing of application (See table of limitations)
Corn rootworms[2] (NHE-26)	June-August	BUX ten dasanit dyfonate phorate	1 1 1 1	Soil surface	As 7-inch band ahead of planter press wheel. Basal treatments with carbaryl, diazinon, disyston, phorate, or parathion equally effective. See pages 2 and 3 for details.
Seed corn maggot Seed corn beetle	At germination	diazinon	See page 3	On seed	For use see page 3.

Note: See footnotes at bottom of page 5.

Insects	Time of attack	Insecticide[1]	Lb. active ingredient per acre	Placement	Timing of application (See table of limitations)
Wireworm (NHE-43)	May-July	aldrin[3]	1 in row 1½ broadcast	In soil	If broadcast, work into soil immediately. 1½ lb. kills only small or medium size worms. Not for dairy farms. Use diazinon to protect seed during germination. See page 3.
White grub (NHE-23)	May-October	heptachlor[3]	Same as aldrin	In soil	
Grape colaspis (NHE-25)	May-July	As for wireworm; broadcast preferred.			
Sod webworm (NHE-42)	May-June	carbaryl	1	At base of plant	At time of initial attack.
Billbugs Cutworm (NHE-38)	May-June	**Broadcast treatment:** apply 1½ lb. of aldrin or heptachlor. For late-planted corn you may use 4 lb. of diazinon as preventive (planting must occur soon after diazinon treatment).			
Emergency treatment:[4]		carbaryl diazinon toxaphene trichlorfon	2-3 2 3 1	At base of plant	When damage is first seen; use 20 gal. of finished spray per acre. Cultivation immediately after application will be helpful.
Garden symphylan	May-July	Dyfonate	1 in row at planting 2 broadcast before planting		If suspected as a problem, use dyfonate for soil insect control.
Grasshopper (NHE-74)	June-September	carbaryl toxaphene	¾ 1½	Over row as spray	As needed. For ensilage corn use carbaryl, diazinon, or malathion.
Flea beetle (NHE-36)	May-June	carbaryl toxaphene	¾ 1½	Over row as spray	When damage becomes apparent on small corn.
Armyworm (NHE-21)	May-June	carbaryl toxaphene trichlorfon	1½ 1½ 1	Over row as spray	At first migration or when damage first becomes apparent.
Fall armyworm (NHE-34)	June; August-September	carbaryl granules toxaphene granules	1½ 1½	In whorls	Granules preferred for whorl. When silking (see earworm).
Chinch bug (NHE-35)	June-August	carbaryl	1	Spray at base of plant	At beginning of migration. Also apply strip in adjacent grain.
Thrips (NHE-39)	June	carbaryl	1	On foliage as spray	When severe wilting and discoloration are noticed.
Corn leaf aphid (NHE-29)		diazinon granules phorate granules	1 1	In whorl	Just before tasseling when aphids are appearing on individual plants. Preventive treatment.
		malathion diazinon methyl parathion[5]	1 1 ¼	As a foliage spray	To clean up severe infestation.
Corn rootworm adults	Late July, early August	carbaryl malathion diazinon methyl parathion[5]	1 1 1 ¼	Overall spray or directed towards silk	When silking is not over 50% and there are more than an average of 5 beetles per ear. Only to protect pollination.
Corn borer, first generation	June-July	carbaryl granules diazinon granules parathion granules bacillus thuringiensis	1½ 1 ½	On upper ⅓ of plant and into whorl	When tassel ratio is 30 to 50, and 75% or more plants show recent borer feeding in whorl.
Corn borer, second generation	Mid-August	carbaryl diazinon parathion[5]	As for first generation ½	From ear upward	At first hatch when there are 1 or more egg masses per plant.
Corn earworm Seed corn only (NHE-33)	July-August	carbaryl Gardona	1½ 1½	Spray ear zone, seed corn only	2 applications at 3- to 5-day intervals, starting at 30-50% silk. 25 gal. of finished spray per acre.

[1] See page 4 for insecticide use restrictions.
[2] Landrin, Mobam, and Furadan also will be recommended for rootworm control upon label approval.
[3] Not for use on dairy farms. Do not apply as foliage sprays or dusts to fields adjacent to dairy pasture, hay, or forage crops.
[4] Dyfonate will be recommended for cutworm control upon label approval.
[5] By experienced applicators only.

SOYBEANS

Insect	Time of attack	Insecticide[1]	Lb. active ingredient per acre	Placement	Timing of application (See table of limitations)
Bean leaf beetle (NHE-67)	May-June, August	carbaryl[2] toxaphene[3]	1 1½	On foliage	When leaf feeding becomes severe, but before plants killed and pods eaten.
Clover root curculio adult (NHE-71)	May-June	carbaryl[2] toxaphene[3]	1 1½	On marginal rows	When clover is plowed, beetles migrate to adjacent beans.
Grasshopper (NHE-74)	June-September	carbaryl[2] toxaphene[3]	¾ 1½	On foliage	When migration from adjacent crops begins.
Flea beetle	May-June	carbaryl[2] toxaphene[3]	1 1½	On foliage	Seedlings usually attacked. Treat when needed.
Green clover worm (NHE-75) and webworm (NHE-42)	August	carbaryl[2] malathion	1 1	On foliage	When damage appears and small worms are numerous between blossom and pod fill.
Mites	June-August	carbophenothion[4] azinphosmethyl[4]	¾ ½	On foliage	As needed on field margins and entire field.
Stink bugs	July and August	carbaryl[2] malathion	1 1	To foliage	As needed but when stink bugs are numerous.
Thrips Leafhoppers	June-August	malathion	1	To foliage	As needed.

[1] See page 4 for insecticide use restrictions on soybeans.
[2] Carbaryl should not be used at more than 1 lb. per acre. Higher rates may damage plants.
[3] For use on dairy farms only when alternate material is not available and when insect emergency exists. Do not apply as foliage sprays or dusts to or adjacent to dairy pasture, hay, or forage crops.
[4] To be applied only by experienced operators or those wearing protective clothing.

STORED GRAIN (Corn, Wheat, and Oats)

Insect	Time of attack	Insecticide and dilution[1]	Dosage	Placement	Suggestions (See table of limitations)
Angoumois grain moth (earcorn) (NHE-62)	April-October (Southern ⅓ of Illinois)	malathion 57% E.C., 3 oz. per gal. water	Apply to runoff	Spray surface and sides in April and August	Plant tight husk varieties. Shelled corn is not affected by Angoumois moth.
Meal moths and surface infestations only (NHE-63)	April-October	malathion 1.0% dust malathion 57% E.C., 3 oz. per gal. water	30 lb. per 1,000 sq. ft. 2 gal. per 1,000 sq. ft.	Spray or dust on surface	Clean and spray bin with 1.5% malathion to runoff before storage. Store only clean dry grain.
General					
Internal and external feeders (NHE-64, 65) Rice and granary weevils	April-October	malathion 1.0% dust malathion 57% E.C., 1 pt. per 3-5 gal. water	40-60 lb. per 1,000 bu. 3-5 gal. per 1,000 bu.	Spray or dust uniformly as grain is binned	Clean and spray bin with 1.5% malathion to runoff before storage. Store only clean dry grain.
Flat grain beetle Saw-toothed grain beetle Rusty grain beetle Foreign grain beetle Cadelle beetle Flour beetle		liquid fumigant; use with caution and avoid breathing vapors	3-5 gal. per 1,000 bu.	On surface; repeat if necessary	Clean and spray bin with 1.5% malathion to runoff before storage. Store only clean dry grain. Apply in late July and September in the southern half of Illinois; apply in mid-August in the northern half of Illinois. Use surface treatment of malathion as recommended for meal moths.

[1] Use only "premium grade" malathion on grain. Malathion vaporizes and is lost rapidly when grain is heat-dried.
Note: E.C. = emulsion concentrate.

SMALL GRAINS

Insect	Time of attack	Insecticide[1]	Lb. active ingredient per acre	Placement	Timing of application (See table of limitations)
Grasshopper (NHE-74)	June-August	carbaryl toxaphene[2]	¾ 1½	On entire plant	Control early while grasshoppers are small.
Chinch bug (NHE-35)	June-July	carbaryl	1	At base of stalk	Treat strip in grain as needed to protect corn from migrating bugs.
Armyworm (NHE-21)	May-June	carbaryl toxaphene[2] trichlorfon	1 1½ ¾	On foliage	When worms are still small and before damage is done.
Greenbug English grain aphid	May-June	demeton[3] parathion[3]	¼ ¼	On foliage	When needed.
Hessian fly	Sept.-October; April-May	disulfoton phorate	½ ½	In drill row	Use granules in a grass-seeder for susceptible varieties planted early.

[1] See page 2 for insecticide use restrictions.
[2] For use on dairy farms only when alternate material is not available and when insect emergency exists. Do not apply as foliage sprays or dusts to or adjacent to dairy pasture, hay, or forage crops.
[3] To be applied only by experienced operators or those wearing protective clothing.

CLOVER AND ALFALFA

Insect	Time of attack	Insecticide[1]	Lb. active ingredient per acre	Placement	Timing of application[2] (See table of limitations)
Alfalfa weevil (NHE-89)	March-June	azinphosmethyl[3,4] methyl parathion[3] malathion[5] with methoxychlor diazinon[5] with methoxychlor[5] malathion[6] Sometimes all materials will spot leaves. Methyl parathion does this more than others.	½ ½ ¾ ¾ ½ 1 1¼	On foliage	Observe carefully after March 15 and when 25% of the tips are being skeletonized treat immediately; two treatments may be necessary on first cutting; regrowth following first cutting may need protection. By ground, use a minimum of 20 gal. of finished spray per acre (10 gal. on stubble) or 4 gal. by air. Do not apply during bloom. Instead cut and remove hay and spray new growth if necessary.
Clover leaf weevil (NHE-12)	March-April	malathion	1	On foliage	When larvae are numerous and damage is noticeable, usually early to mid-April.
Spittlebug (NHE-13)	Late April, early May	methoxychlor	¾	On foliage	When bugs begin to hatch and tiny spittle masses are found in crowns of plants.
Aphid (NHE-14 and 19)	April-May	demeton[3] diazinon malathion	¼ ½ 1	On foliage	When aphids are becoming abundant.
Leafhopper (NHE-22)	Early July	carbaryl methoxychlor	1 1	On foliage	When second-growth alfalfa is 1 to 6 inches high, or as needed.
Garden webworm (NHE-42)	July-August	carbaryl toxaphene[7]	1 1½	On foliage	When first damage appears. Use toxaphene only on new fall seedlings.
Cutworm (NHE-77)	April-June	carbaryl	1½	On foliage	Cut, remove hay, and spray immediately.
Armyworm (NHE-21)	May-June, September	carbaryl malathion	1½ 1	On foliage	Only when grasses are abundant.
Seed crop insects	July-August	toxaphene[7]	1½	On foliage	No later than 10% bloom.
Grasshopper (NHE-74)	June-September	carbaryl diazinon malathion naled	¾ ½ 1 ¾	On foliage	When grasshoppers are small and before damage is severe.
Sweet clover weevil (NHE-15)	April-May	toxaphene[7]	1½	On foliage	When 50% of foliage has been eaten. New seedlings only.

[1] See page 4 for insecticide use restrictions.
[2] Before applying insecticides, be certain to clean all herbicides out of equipment. During pollination, apply very late in day.
[3] To be applied only by experienced operators or those wearing protective clothing.
[4] Water temperature should be above 55°F.
[5] Use no less than these amounts.
[6] Use only when air temperature is above 60°F.
[7] Not for use on dairy farms. Do not apply as foliage sprays or dusts to fields adjacent to dairy pasture, hay, or forage crops.

TOXICITY AND PERSISTENCY RATINGS FOR INSECTICIDES[1]

Insecticide	Toxicity to Warm-blooded animals	Toxicity to Fish	Persistency as a residue
aldrin	2	1	1
azinphosmethyl	1	...	3
carbaryl	4	6	3
carbophenothion	1	...	2
demeton	1	3	3
diazinon	3	2	3
disulfoton	1	...	3
heptachlor	2	1	1
malathion	5	3	6
methoxychlor	6	1	4
naled	3	2	6
parathion	1	2	3
phorate	1	...	3
toxaphene	3	1	1
trichlorfon	4	6	5

[1] A rating of 1 indicates high toxicity or persistence of residue; a rating of 6 indicates low toxicity (relatively safe) and little persistency.

FOR YOUR PROTECTION: Always handle insecticides with respect. The persons most likely to suffer ill effects from insecticides are the applicator and his family. Accidents and careless, needless overexposure can be avoided. Here are a few rules that if followed will prevent most insecticide accidents:

1. Wear rubber gloves when handling insecticide concentrates.
2. Do not smoke while handling or using insecticides.
3. Keep your face turned to one side when opening, pouring from, or emptying insecticide containers.
4. Leave unused insecticides in their original containers with the labels on them.
5. Store insecticides out of reach of children, irresponsible persons, or animals; store preferably in a locked building. Do not store near livestock feeds.
6. Wash out and bury, burn, or haul to the refuse dump all empty insecticide containers.
7. Do not put the water-supply hose directly into the spray tank.
8. Do not blow out clogged nozzles or spray lines with your mouth.
9. Wash with soap and water exposed parts of body and clothes contaminated with insecticides.
10. Do not leave puddles of spray on impervious surfaces.
11. Do not apply to fish-bearing or other water supplies.
12. Do not apply insecticides, except in an emergency, to areas with abundant wildlife.
13. Do not apply insecticides near dug wells or cisterns.
14. Do not spray or dust when weather conditions favor drift.
15. Observe all precautions listed on the label.
16. To avoid bee kill, apply insecticides after bee activity has been completed for the day; use the least toxic materials. *Warn beekeepers that you are applying insecticides.*

Cooperative Extension Work, University of Illinois, College of Agriculture, and the U.S. Department of Agriculture cooperating.
JOHN B. CLAAR, *Director.* Act approved by Congress May 8 and June 30, 1914.

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1969 Suggested Insecticide Guide

Insect Control BY THE HOMEOWNER

Much has been said about the effects of pesticides, particularly insecticides, on the health and well-being of the American people. The homeowner, however, is also aware that he is constantly faced with a horde of insects, intent upon destroying his property or making his life uncomfortable. Occasionally he can avoid or reduce the destruction wrought by some pests without using an insecticide, but to control most insects, he must rely on an insecticide. This will provide the satisfactory control that he demands.

By careful use of insecticides, the homeowner can enjoy reasonable freedom from insects without endangering either himself, his family, or his pets. He must recognize, however, that insecticides are designed to destroy one group of animals — insects — and can be harmful to other animals, including man himself, if used with disregard of normal safety precautions. It is up to each insecticide user to handle, apply, and store insecticides safely to reap their benefits without suffering from their dangers. For further information on safe use of pesticides Circular 906 is available from the College of Agriculture at Urbana.

Read the labels and follow instructions carefully. A few million dollars were spent on research to discover the information they contain.

The suggestions in this publication list certain insecticides to control insect pests of food, fabric, structures, man and animals, lawns, shrubs, trees, flowers, fruits, and vegetables. Others might control the insect, but we have tried to suggest only the safest materials and have tried to simplify the list of insecticides that the homeowner needs. However, with the wide variety of problems and situations, several insecticides are required to meet the needs of the homeowner. Many people prefer to employ the services of a professional exterminator or custom applicator rather than to become involved with selection and application of an insecticide.

The names used in these tables are the common coined chemical names, not the trade names, and as such may not be familiar to you. The common name for *DDVP* is *dichlorvos,* for *Kelthane* it is *dicofol,* and for *Sevin* it is *carbaryl.* If there is no coined chemical name, the trade name is used but is capitalized.

Insecticides can be purchased from garden centers, drug, hardware, grocery, and seed stores, and from exterminators and other sources.

In using these tables always read the footnotes before using the insecticides. They list precautions and other pertinent information.

Leaflets on specific insects, their life history, habits, damage, and cultural control methods are available from the county extension adviser or by writing to Office of Agricultural Publications, University of Illinois College of Agriculture, Urbana, Illinois 61801. They are indicated in tables by NHE or Circular numbers.

Other circulars on insect control are:

Circular 897 — Insect Control for Commercial Vegetable Crops and Greenhouse Vegetables;

Circular 898 — Insect Control for Livestock and Livestock Barns;

Circular 899 — Insect Control for Field Crops;

Circular 936 — Pest Control in Commercial Fruit Plantings.

These are available from the county offices or the College of Agriculture at Urbana.

These suggestions are revised annually. Suggestions sometimes change during the growing season, so these are subject to change without notification.

These suggestions were prepared by entomologists of the University of Illinois College of Agriculture and the Illinois Natural History Survey.

CIRCULAR 900 UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE
In cooperation with ILLINOIS NATURAL HISTORY SURVEY Urbana, Illinois, December, 1968

Cooperative Extension Work, University of Illinois, College of Agriculture, and the U.S. Department of Agriculture cooperating. JOHN B. CLAAR, Director. Acts approved by Congress May 8 and June 30, 1914.

VEGETABLE INSECTS

Insects	Crop	Insecticide	Suggestions
Aphids (NHE-47) Leafhoppers (NHE-22) Mites (NHE-58) Thrips	Most garden crops	malathion	Apply on foliage to control the insects. Aphids and leafhoppers transmit plant diseases; early control is important. Mites web on the underside of leaves; apply insecticide to underside of leaves early before extensive webbing occurs.
Blister beetles (NHE-72) Cutworms (NHE-77) Flea beetles (NHE-36) Grasshoppers (NHE-74) Leafhoppers (NHE-22) Picnic beetles (NHE-40)	Most garden crops	carbaryl	For cutworms, attach collars of paper, aluminum foil, or metal at planting for small numbers of plants, or apply insecticide to base of plants at first sign of cutting. Control grasshoppers in garden borders when hoppers are small. For picnic beetles, pick and destroy overripe or damaged vegetables.
Wireworms (NHE-43) and other soil insects (NHE-23, 27)	Most garden crops	diazinon	When tearing up sod for a garden, apply to soil and rake in before planting.
All cabbage worms (NHE-45)	Cabbage and related crops, salad crops, and leafy vegetables	carbaryl or malathion	Presence of white butterflies signals start of infestation. Control worms when small. It is almost impossible to raise cole crops in Illinois without controlling these pests.
Hornworms	Tomatoes	carbaryl	Handpicking usually provides satisfactory control.
Earworms (NHE-33)	Tomatoes and sweet corn	carbaryl	Apply to late-maturing tomatoes 3 to 4 times at 5- to 10-day intervals from small-fruit stage. Apply at fresh-silk stage to early and late corn every 2 days 4 to 5 times.
Colorado potato beetles	Eggplant, potatoes, tomatoes	carbaryl	Apply as needed. Insects usually present only in late May and June.
Potato leafhoppers (NHE-22)	Potatoes, beans	carbaryl or malathion	Apply 3 to 4 times at weekly intervals starting in late May or early June. Late potatoes and beans require additional treatments. Most serious pest of potatoes and beans in Illinois.
Bean leaf beetles (NHE-67)	Beans	carbaryl	Leaves are riddled in early plantings. Apply once or twice as needed.
Mexican bean beetle	Beans	carbaryl	Except for southern Illinois, only a pest of late beans. Apply insecticide to underside of leaves.
Cucumber beetles (NHE-46)	Vine crops	carbaryl or malathion	Apply as soon as beetles appear in spring. When blossoming begins, apply insecticide late in the day so as not to interfere with pollination by bees.
Squash vine borers	Squash	carbaryl	Make weekly applications to crowns and runners when plants begin to vine. Apply late in day.
Squash bugs (NHE-51)	Squash and pumpkins	carbaryl	Apply as soon as small nymphs are seen and as needed. Does not kill large nymphs and mature bugs. Apply late in day.
Corn borer	Sweet corn	carbaryl	Apply 4 times every 3 days to whorl and ear zone of early corn when feeding appears on whorl leaves.

Days to Wait Between Application and Harvest

	Collards, kale, and other leafy crops	Beans	Lettuce	Cabbage and related crops	Sweet corn	Onions	Vine crops[1]	Tomatoes	Pumpkin	Eggplant	Peas	Potatoes
carbaryl	14	0	14	3	0	..	0	0	0	0	0	0
malathion	7	1	14	7	5	3	1	1	3	3	3	0

[1] Only apply insecticide late in the day after blossoms have closed to avoid bee kill.

Amount of Insecticide for Volume of Spray

	1 gal.	6 gal.	100 gal.	Commercial dust
carbaryl 50% W.P.	2 tbl.	¾ cup	2 lb.	5%
malathion 50-57% E.C.	2 tsp.	4 tbl.	1 qt.	4%

Apply 1 ounce of actual diazinon per 1,000 square feet. To do this mix ¼ pint (4 fluid ounces) of 25% diazinon emulsion in enough water to cover 1,000 square feet, usually 2 to 3 gallons of water. Rake into soil.

Note: E.C. = emulsion concentrate; W.P. = wettable powder.

FRUIT INSECTS

Insects	Crop	Insecticide[1]	Suggestions[2]
Apple maggot (NHE-108) Codling moth (NHE-98) Green fruit worm Leaf rollers	Apple	malathion methoxychlor diazinon	Apply once just ahead of bloom and repeat every 10 to 14 days after bloom until July 15. Continue spray program in northern Illinois until August 15 for apple maggot control.
Aphids	Most fruits	diazinon malathion	Apply when aphids first appear on leaves.
Apple tree borers	Apple	carbaryl	Spray trunks of young trees beginning in June for 2 to 3 applications. Keep young trees vigorous.
Plum curculio (NHE-101)	Apple, peach, apricot, plum, and cherry	methoxychlor malathion	Use methoxychlor just before bloom and repeat every 10 to 14 days for 3 applications. Do not spray during bloom.
Scale (NHE-100)	Most fruits	malathion	Apply in May during crawler stage. Dormant oil spray may be applied in spring before leaf buds open.
Oriental fruit moth (NHE-99)	Peach and apricot	methoxychlor malathion	Make first application at petal fall. Repeat every 10 to 14 days. Malathion can be added to suppress mites. First generation damages terminal hosts, second and third enter fruit.
Peach tree borers (NHE-112)	Peach, apricot, plum, and cherry	carbaryl	Thoroughly spray trunk and limbs of peach trees beginning about June 1. Repeat every 2 to 3 weeks through July.
Tarnished plant bug Stink bug	Peach and apricot	malathion methoxychlor	Make first application at petal fall, plus 2 more applications 10 to 14 days apart.
Mites	Most fruits	malathion dicofol	Either malathion or dicofol should be included in the spray mixture to prevent mite buildup.
Periodical cicada	Apple and peach	carbaryl	Apply spray every 7 to 10 days.
Raspberry fruit worm Raspberry cane borers	Raspberry	methoxychlor malathion	Apply just before buds open and repeat in 2 weeks.
Grape berry moth	Grape	malathion methoxychlor diazinon	Apply to first generation larvae immediately after bloom and apply sprays again 35 to 45 days later for second brood.
Strawberry leafroller Strawberry weevil Strawberry crown borers	Strawberry	diazinon malathion methoxychlor	Apply once before bloom and again after bloom. If leafroller remains a problem after harvest, make an additional application.

[1] There are multi-purpose or all-purpose fruit sprays available commercially for use by the home fruit grower. These mixtures usually contain 2 fungicides for disease control and 2 insecticides. The insecticides differ in that one is a short-duration, quick-killing chemical such as malathion and the other is a more residual insecticide such as methoxychlor. These two insecticides will effectively control most large and small fruit insects if used throughout the growing season. Sometimes, a miticide has to be added for more effective mite control. Carbaryl thins or reduces the number of apples on a tree if used earlier than three weeks after bloom.

[2] Dates of application refer to central Illinois. In southern Illinois apply two weeks earlier and in northern Illinois two weeks later.

Days to Wait Between Application and Harvest

	Apples and pears	Peaches and apricots	Plums	Cherries	Grapes	Raspberries	Strawberries
carbaryl (Sevin)	1	3	3	1	1	7	1
diazinon	14	20	10	10	10	..	5
dicofol (Kelthane)	7	14	7	7	7	2	2
malathion	3	7	3	7	3	1	3
methoxychlor	7	21	7	7	14	3	3

Amount of Insecticide for Volume of Spray

	1 gal.	6 gal.	100 gal.
carbaryl 50% W.P.	2 tbl.	¾ cup	2 lb.
diazinon 25% W.P.	2 tbl.	¾ cup	2 lb.
dicofol 18.5% W.P.	2 tbl.	¾ cup	2 lb.
malathion 25% W.P.	1½ tbl.	½ cup	1½ lb.
methoxychlor 50% W.P.	2 tbl.	¾ cup	2 lb.

Note: E.C. = emulsion concentrate; W.P. = wettable powder.

TREE AND SHRUB INSECTS

Insects	Insecticide	Suggestions[1]
Aphids (NHE-7)	diazinon malathion	Spray foliage thoroughly with force. Repeat as needed.
Bagworms (NHE-6)	carbaryl diazinon malathion	Spray foliage thoroughly. Apply June 15. Later sprays are less effective.
Borers (NHE-8)	DDT	Spray trunk monthly in summer, beginning about May 15. Do not spray foliage. Wrap trunks of newly set trees with heavy paper for first two years or until trees are growing vigorously.
Catalpa sphinx	carbaryl malathion	Spray foliage when feeding or worms are first noticed.
Eastern tent caterpillars	Same as for catalpa sphinx	Spray when nests are first noticed.
Elm leaf beetle (NHE-82)	carbaryl	Spray as soon as damage is noticed.
European pine shoot moths and Nantucket pine moth (NHE-83)	DDT	Spray ends of branches thoroughly in mid-April and late June.
Fall webworms	carbaryl diazinon malathion	Spray when first webs appear; clip off and destroy infested branches or burn out webs.
Galls (NHE-80, 81) Elm cockscomb Hickory	 diazinon malathion	 Spray foliage thoroughly when buds are unfolding.
Hackberry blister	diazinon malathion	Spray foliage thoroughly in late May. Kills psyllids in galls.
Cooley spruce Eastern spruce	Either spray above	Apply in late September or October or early spring just before buds swell.
Green-striped mapleworms	Same as for catalpa sphinx	Spray as soon as damage is noticed.
Leaf miners Boxwood Hawthorn Oak	diazinon malathion	Spray foliage thoroughly when mines first appear. Repeat treatment in 10 to 12 days.
Mealybugs	malathion	Spray foliage thoroughly and with force. Repeat in two weeks.
Mimosa webworms (NHE-109)	carbaryl malathion	Spray foliage thoroughly when first nests appear (June, July). A repeat treatment may be needed.
Mites (NHE-58)	chlorobenzilate dicofol	Pay particular attention to underside of leaves. Apply 2 or 3 times at weekly intervals.
Oak kermes	malathion	Spray foliage thoroughly about July 1 to kill the crawlers.
Periodical cicadas (NHE-113)	carbaryl	Spray all branches thoroughly when adults appear. Repeat in 7 to 10 days.
Sawflies	Same as for fall webworms	Spray as soon as worms or damage is evident.
Scale (NHE-114) Cottony maple European elm Oystershell Pine needle Scurfy Spruce bud Sweet gum	malathion	Spray foliage thoroughly in early April for Fletcher and European elm scale; in late May for pine needle and sweet gum scale; in early June for scurfy, oystershell, and euonymous scale; in early July for cottony maple, Juniper, and dogwood scales; in mid-July for spruce bud scale; and again in early August for oystershell scale.
Putnam San Jose Tulip tree	dormant oil diluted according to label	Apply when plants are still dormant in late winter. Do not use on evergreens. For tulip tree scale, a malathion spray in late September or in early spring is also effective.

[1] Treatment dates are listed for central Illinois. In southern Illinois apply 2 week earlier and in northern Illinois 2 weeks later.

TREE AND SHRUB INSECTS (continued)

Insects	Insecticide	Suggestions[1]
Spring cankerworms	Same as for catalpa sphinx	When leaf buds open in spring, while worms are still small.
Spruce budworms	Same as for fall webworm	Spray when caterpillars are noticed.
Sycamore lace bugs	carbaryl malathion	Spray when nymphs appear, usually in late May.
Thrips	Same as for aphids	Mainly on privet. Spray foliage thoroughly. Do not use DDT on privet.
Yellow-necked caterpillars	Same as for catalpa sphinx	Spray foliage when worms are small.
Zimmerman pine moths	DDT	Spray whorl area of trunk and large limbs. Cut and burn dying branches in July.

[1] Treatment dates are listed for central Illinois. In southern Illinois apply 2 weeks earlier and in northern Illinois 2 weeks later.

Amount of Insecticide Needed for Volume of Spray

	1 gal.	6 gal.	100 gal.		1 gal.	6 gal.	100 gal.
carbaryl 50% W.P.[1]	2 tbl.	¾ cup	2 lb.	chlorobenzilate 25% W.P.	1 tsp.	2 tbl.	2 lb.
diazinon 25% E.C.[2]	2 tsp.	4 tbl.	1 qt.	dicofol 18.5% E.C.	2 tsp.	4 tbl.	1 qt.
lindane 20% E.C.	1 tsp.	2 tbl.	1 pt.	DDT 25% E.C.[4]	3 tbl.	1 cup	2 gal.
malathion 50-57% E.C.[3]	2 tsp.	4 tbl.	1 qt.				

[1] Do not use on Boston ivy. [2] Do not use on ferns or hibiscus. [3] Do not use on canaert red cedar. [4] Do not use on privet. Note: E.C. = emulsion concentrate; W.P. = wettable powder.

LAWN INSECTS

Insects	Insecticide[1]	Dosage per 1,000 sq. ft.[2]	Suggestions
True white grubs Annual white grubs Japanese beetle larvae Green June beetle larvae Ants	chlordane 45% E.C. 40% W.P. 10% G. 5%	½ cup 5 oz. 1¼ lb. 2½ lb.	Provides 5-year protection. In established sod, apply as granules or spray to small area and then water in very thoroughly before treating another small area. For new seedings, mix in soil before planting. Do not plant vegetable root crops in treated soil for 5 years.
Ants Cicada killer and other soil-nesting wasps	diazinon 25% E.C. 2% G.	¾ cup 5 lb.	Apply as spray or granules and water in thoroughly. For individual nests pour 1% diazinon in nest. Seal in with dirt.
Sod webworms Millipedes and sowbugs	carbaryl 50% W.P. 5% G. diazinon 25% E.C. 2% G. trichlorfon 50% W.P. 5% G.	½ lb. 4 lb. ¾ cup 5 lb. 4 oz. 2½ lb.	As sprays, use at least 2.5 gal. of water per 1,000 sq. ft. Do not water for 72 hours after treatment. As granules, apply from fertilizer spreader.
Armyworms Cutworms Chinch bugs	carbaryl 50% W.P. 5% G.	2 oz. 1 lb.	Apply as sprays or granules. Use 5 to 10 gal. of water per 1,000 sq. ft.
Leafhoppers	carbaryl 50% W.P. methoxychlor 25% E.C.	2 oz. 2 oz.	Apply as a spray.
Chiggers	diazinon	1 tbl.	Spray grass thoroughly.
Mites	dicofol 18.5% E.C. malathion 50-57% E.C.	1 tbl. 1 tbl.	Spray grass thoroughly, 2 to 2.5 gal. of water per 1,000 sq. ft.
Slugs	Slug baits	Scatter in grass	Apply where slugs are numerous.

[1] E.C. = emulsion concentrate; W.P. = wettable powder; G. = granules.
[2] To determine lawn size in square feet, multiply length times width of lawn and subtract non-lawn areas including house, driveway, garden, etc. Do not allow people or pets on lawn until the spray has dried.

FLOWER INSECTS

Insect	Insecticide[1]	Dosage	Suggestions
Ants, white grubs, and soil-nesting wasps (NHE-17, 79, 111)	chlordane 45% E.C.	4 oz. per gal. water	Spray over 1,000 square feet of soil and water in thoroughly. Do not spray on plant foliage. Do not plant vegetable root crops on treated soil for 5 years.
Aphids, mealybugs, lacebugs, scales, and white flies (NHE-7, 114)	malathion 50-57% E.C.	2 tsp. per gal. water	Spray foliage thoroughly. Repeat treatments may be needed.
Blister beetles (NHE-72)	carbaryl 50% W.P.	2 tbl. per gal. water	Spray foliage. Repeat treatments may be needed.
Cutworms (NHE-77)	diazinon 25% E.C. diazinon 2% granules	6 oz. per 2-3 gal. water 5 lb. per 1,000 sq. ft.	Spray 1,000 sq. ft. soil at base of plants. Do not spray on plant foliage. Small numbers of plants can be protected with collars of paper, aluminum foil, or metal.
Grasshoppers (NHE-74)	carbaryl 50% W.P. malathion 50-57% E.C.	2 tbl. per gal. water 2 tsp. per gal. water	Spray foliage and also adjacent grassy or weedy areas.
Iris borer	DDT 25% E.C. dimethoate 2% E.C.	1 oz. per gal. water 4 tsp. per gal. water	Spray DDT as soon as new leaflets appear and repeat 4-6 times at weekly intervals. Apply dimethoate when irises are in bloom, but not on blooms and make only one application.
Leaf-feeding beetles	carbaryl 50% W.P.	2 tbl. per gal. water	Spray foliage. Repeat treatments if needed.
Leaf-feeding caterpillars	Same as for leaf-feeding beetles		
Plant bugs and leafhoppers	Same as for leaf-feeding beetles		
Slugs (NHE-84)	Metaldehyde		Apply as a bait to soil. Remove old leaves, stalks, poles, boards, and other debris where slugs like to hide and lay eggs.
Sowbugs	DDT 25% E.C. DDT 5% dust	1 oz. per gal. water	Spray or dust soil around plants. Remove boards and trash under which bugs hide.
Spider mites (NHE-58)	chlorobenzilate 25% W.P. dicofol 18.5% E.C.	2 tsp. per gal. water	Pay particular attention to underside of leaves when spraying. Apply 2 or 3 times at weekly intervals.
Springtails	malathion 50-57% E.C. malathion 4% dust	2 tsp. per gal. water	Spray foliage and soil. Apply to soil at base of plants.
Stalk borers (NHE-24)	Same as for leaf-feeding beetles		Spray foliage thoroughly and frequently.
Thrips	Same as for leaf-feeding beetles		Spray foliage carefully.

[1] Do not use oil-base sprays on plants. Do not use malathion on African violets. Do not use carbaryl on Boston ivy. Do not use diazinon on ferns. Repeated use of DDT and carbaryl foliage sprays may cause mite or aphid infestations to increase and become damaging. Do not use insecticides during full bloom.

Note: E.C. = emulsion concentrate; W.P. = wettable powder. An emulsion concentrate is a chemical pesticide dissolved in a solvent to which an emulsifier has been added. It can then be mixed with water to the desired strength before being used.

READ THE LABEL AND STUDY THE PRECAUTIONS ON PAGE 8

ANIMAL AND NUISANCE INSECTS

Insects	Insecticide[1]	Method of application	Suggestions
Flies, mosquitoes, gnats (NHE-16, 94)	Outdoors: malathion 0.5% Purchase E.C. and dilute with water	Spray shrubbery, flowers, and tall grass, and around doorways and refuse containers.	Dispose of refuse twice each week. Eliminate standing water in eaves troughs, old tires, toys, tin cans, etc.
	Indoors: pyrethrin 0.1% space spray or 20% dichlorvos resin strips[2]	Use fine mist or fog of pyrethrin or 1 resin strip per 1,000 cu. ft.	Use Dimetilan 4% plastic bands in attached garages (1 per 100 sq. ft.). Use screening and keep repaired.
Fleas (NHE-107) Brown dog tick	carbaryl 5% dust malathion 4% dust	Dust areas inside and outside the home where the pet rests.	Dust pets as needed. For cleanup of ticks indoors use 0.5% diazinon.
Chiggers and ticks (NHE-56)	diazinon	8 oz. per 10,000 sq. ft. of lawn.	For people use DEET as a repellent.
Hornets, wasps, bees, spiders (NHE-17, 116)	dichlorvos 1% O.[2] malathion 1% O. or 4% dust	Treat nests of bees, wasps or hornets after dark. For soil nests treat as for ants (p. 5 under lawn insects).	For spiders same as for ants (p. 5). For wasp or bee nests in partitions remove exterior siding, spray nests, remove nest and replace siding.
Cluster flies (NHE-1)	20% dichlorvos resin strips[2]	1 strip per 1,000 cu. ft. in attic or room.	Seal cracks around windows, eaves, and siding to prevent entry.
Elm leaf beetles (NHE-82) Boxelder bugs (NHE-9)	dichlorvos 0.5%[2] pyrethrin 0.1%	Brush or spray inside surfaces of window casements.	Spray on sides and foundation of house and 3 ft. of adjacent soil with 2% chlordane for elm leaf beetle or 0.5% dieldrin for boxelder bugs. Removal of seed-bearing boxelder trees will help.
Clover mites (NHE-2)	chlorobenzilate 0.25% dicofol 0.05% Purchase E.C. and dilute with water	Spray outside of the house from ground up to windows and adjacent 10 ft. of lawn.	Remove grass and weeds from 18-inch strip next to foundation. Vacuum, or spray with 0.1% pyrethrin in house.
Millipedes, centipedes, or sowbugs (NHE-93)	diazinon carbaryl trichlorfon	Spray outside foundation and at least 3 ft. of adjacent soil.	Treat entire lawn as for webworms if pests are abundant. Collect with vacuum when found indoors.
Picnic beetle	carbaryl 50% W.P.	2 tbl. per gal. water.	Apply to garbage pails and other decaying vegetable refuse frequented by these beetles.
Springtails	malathion 50-57% E.C. malathion 4% dust	2 tsp. per gal. water.	Spray foliage and soil next to house.
Drainflies (NHE-91)	*Outdoors:* malathion 0.5%	Spray shrubbery, tall grass, and refuse containers.	Use chemicals only after solving sanitation problems. Clean out overflow drains, drain traps, and cellar drains. Pour boiling water or rubbing alcohol into overflow drain to eliminate maggots.
	Indoors: pyrethrin 0.1% space spray or 20% dichlorvos resin strip	Use fine mist or fog of pyrethrin or 1 resin strip per 1,000 cu. ft.	
Larder beetles	None		Removal of source such as dead animal carcasses.

[1] SPECIAL NOTE: Whenever possible purchase especially prepared ready-to-use forms of insecticides for indoor use. Do not use oil-base sprays on plants or near open flames. Do not spray or dust food, food-handling surfaces (counters, chopping boards, etc.), or cooking and eating utensils.

[2] Do not use in pet shops or if tropical fish are present.

Note: E.C. = emulsion concentrate; W.P. = wettable powder; O. = oil solution (usually available in pressurized spray can).

FOOD, FABRIC, AND STRUCTURAL INSECTS

Insects	Insecticide[1]	Method of application	Suggestions
Ants (NHE-111, Cir. 887) Crickets Spiders (NHE-116)	diazinon 0.5% chlordane 2%	Spray runways and outside foundation.	To prevent insect migrations into house, use E.C. diluted with water and spray completely around outside foundation wall and adjacent 4-inch strip of soil.
Cereal insects (NHE-11) Drugstore beetle Cigarette beetle	pyrethrin 0.1% dichlorvos 0.5% diazinon 0.5%	Spray or dust inside food cabinets and shelves.	Discard infested packages. Brush out or vacuum food cabinets and shelves. Do not use dichlorvos in pet shops or if tropical fish are present.
Roaches (NHE-3,4,5)	diazinon 0.5% O. pyrethrin 0.1%	Spray runways and hiding places.	More complete treatment is needed for successful control of brown-banded roach. Repeat treatments may be needed in 2 or 3 weeks. Pyrethrins flush roaches from concealed places but kill only those hit with spray. There is no residual action.
Clothes moths and carpet beetles (NHE-87) Tissue paper beetle	diazinon 0.5%	Spray storage areas and any infested places.	Recently cleaned or washed woolens may be safely stored in insect-free chests and plastic bags. Air and brush other woolens in bright sunlight before storing, or treat lightly with diazinon.
Silverfish (NHE-86)	diazinon 0.5%	Spray runways.	Baits using 1 part sodium fluoride plus 9 parts pancake flour are also effective.
Termites (NHE-57)	chlordane 1% dieldrin 0.5% Purchase E.C. and dilute with water or oil	Soak 6-inch width of soil down to footing around and beneath building, 1 gal. per 2 cu. ft. of soil.	Remove termite mud tubes connecting wood to soil. Eliminate wood-to-soil contacts. Ventilate to keep unexcavated areas dry.
Powder-post beetles (NHE-85)	chlordane 2% O. DDT 5% O. pentachlorophenol 5% O.	Spray or brush on infested wood several times.	Pentachlorophenol is a wood preservative also, but it has a strong persistent odor.
Carpenter ants (NHE-10)	chlordane 2% O. or 5% dust dieldrin 0.5% O. or 1% dust	Spray or dust nest entrances.	Use foundation sprays as recommended for ants.

[1] Purchase especially prepared ready-to-use forms of insecticides for indoor use. Do not use oil-base sprays on plants or near open flames. Do not spray or dust food, food-handling surfaces (counters, chopping boards, etc.) or cooking and eating utensils.

Note: E.C. = emulsion concentrate; W.P. = wettable powder; O. = oil solution (usually available in pressurized spray cans).

FOR YOUR PROTECTION

Always handle insecticides with respect. After all, the people most likely to suffer ill effects from insecticides are the applicator and his family. Accidents and careless, needless overexposure can be avoided. From 1960 through 1966 there were 22 deaths in Illinois caused by accidental ingestion of pesticides: 13 from insecticides, 5 from rodenticides, and 4 due to a herbicide. Of these 22, nine were from baits.

Each year more than 750 Illinois children under 12 years of age are rushed to a doctor because of suspected pesticide ingestion or excessive exposure. A study of such cases showed that 50 percent of the children obtained the pesticide while it was in use and 13 percent obtained it from storage (the source was not known in the rest). Fifty-three percent involved insecticides used as baits. All these accidents could have been prevented. The following suggestions for safe use of pesticides are designed to prevent such unfortunate careless accidents.

1. Store insecticides out of reach of children, irresponsible persons, or animals; store preferably in a locked cabinet.
2. If you use a bait around or in the home, place it after the children have retired and pick it up in the morning before they get up. Furthermore, place it out of their reach. At present we do not encourage use of baits for insect control.
3. Put insecticide containers back in the storage area before applying insecticide. Small children have found open bottles by the water tap.
4. Avoid breathing insecticide sprays and dusts over an extended period. This is particularly true in enclosed areas such as crawl spaces, closets, basements, and attics.
5. Wash with soap and water exposed parts of body and clothes contaminated with insecticide.
6. Wear rubber gloves when handling insecticide concentrates.
7. Do not smoke while handling or using insecticides.
8. Do not blow out clogged nozzles with your mouth.
9. Leave unused insecticides in their original containers with the labels on them and in locked cabinets.
10. Wash out and bury or burn and haul to the refuse dump empty insecticide containers.
11. Do not leave puddles of spray on impervious surfaces.
12. Do not apply insecticides to fish ponds.
13. Do not apply insecticides near dug wells or cisterns.
14. Do not apply insecticides in vicinity of beehives or on blooming plants.
15. Observe all precautions listed on the label.
16. To avoid bee kill, apply insecticides after bee activity has been completed for the day; use the least toxic materials. *Warn beekeepers that you are applying insecticides.*

21M—12-68—99122

Herbicide Guide 1969
FOR COMMERCIAL VEGETABLE GROWERS

WEED GROWTH reduces vegetable growers' income in the United States by millions of dollars annually as a result of lower yields, poorer quality, and added labor in harvesting and processing the crops.

This guide should be used together with the grower's knowledge of soil types and the crop and weed history of the area to be treated. The decision of whether to use herbicides or other means of weed control depends in part on the severity of past weed infestations. Several herbicides may be suggested for some crops. These herbicides have shown good control with no injury to the vegetables under test conditions. Not all herbicides cleared for use on a species are necessarily listed. Where the choice of more than one herbicide is suggested, the decision rests with the grower and is based on his knowledge of past weed infestation and cost of material. When using an herbicide for the first time, a small-scale trial is advised.

These suggestions for chemical weed control in vegetables are based on research at the Illinois Agricultural Experiment Station, the U.S. Department of Agriculture, and other research institutions. The University of Illinois and its agents assume no responsibility for results from the use of these herbicides, whether or not they are used in accordance with suggestions, recommendations, or directions of the manufacturer or any governmental agency.

Reading the label of the herbicide container is the most profitable time you spend in weed control. Use of the material and methods of use depend on registration of the herbicide by the federal Food and Drug Administration. Do not use any herbicide *unless the label states that it is cleared for the use on the crop to be treated.*

Where mixtures of chemicals are applied the *user* will assume the responsibility for freedom from residues if such applications are not labeled by the FDA as a mixture.

Suggestions sometimes change during the growing season based on FDA clearances after date of issue. These suggestions are printed only once each year, and are therefore subject to change without notification. Changes during the year are released in the Illinois Vegetable Farmer's Letter.

In 1969 some herbicides may not be available for use because of loss of a no-tolerance residue basis. Watch for notice of these herbicides (as they are identified by the FDA) in the Illinois Vegetable Farmer's Letter. The Letter is available from the Department of Horticulture, University of Illinois, Urbana 61801.

NOTE: In the suggestions table on the following pages, the trade names of the herbicides are usually used. The list immediately below shows trade names and their corresponding common names.

Common name	Trade name
amiben	Amiben, Vegiben
atrazine	Aatrex, Atrazine
benefin	Balan
bensulide	Prefar
butylate	Sutan
CDAA	Randox
CIPC	Chloro IPC
dalapon	Dowpon
diuron	Karmex
DCPA	Dacthal
diphenamid	Dymid, Enide
EPTC	Eptam
linuron	Lorox
monuron	Telvar
MCPA	Numerous
MCPB	Numerous
naptalam	Alanap
nitrofen	TOK
PEBC	Tillam
propachlor	Ramrod
pyrazon	Pyramin
simazine	Princep, Simazine
trifluralin	Treflan
Petroleum solvent	Stoddard Solvent
2,4-D (amine)	Numerous

UNIVERSITY OF ILLINOIS · COLLEGE OF AGRICULTURE · COOPERATIVE EXTENSION SERVICE — CIRCULAR 907
Prepared by H. J. Hopen, Department of Horticulture

Crop	*Herbicide*	*Rate of active ingredient per acre actually covered*[1]	*Weeds controlled*	*Best time of application (based on crop stage)*	*Remarks, cautions, limitations*
Asparagus (seedlings)	Amiben	3 lb.	Annuals	Immediately after seeding	Irrigation or rainfall after treatment will give maximum control.
Asparagus (established planting)	Dowpon	5-10 lb.	Perennial grass	End of harvest season following disking	Apply when grass weeds are 3 to 4 inches tall.
	Telvar	3 lb.	Annuals	In spring before spears emerge and immediately following harvest	Apply Telvar after disking. Do not exceed 6 lb. per growing season.
	Karmex	3 lb.	Annuals		Apply Karmex after disking. Do not exceed 4.8 lb. per growing season. Do not replant treated area to any other crop for 2 years after last application.
	Princep	3-4 lb.	Annuals	In spring and after harvest	Apply after disking. Apply only once a year after first year. Do not treat during last year in asparagus because of residue.
Beans, lima and dry	Amiben	3 lb.	Annuals	Immediately after seeding	Field may be rotary-hoed without destroying herbicide action. Do not feed foliage to livestock.
	Amiben plus Randox	2 lb. +2 lb.	Annuals	Immediately after seeding	Gives sustained annual grass control.
	Treflan	0.75 lb.	Annuals[2]	Preplant soil application Incorporate with soil immediately	Plant crop immediately or within 3 weeks after application. Can be used up to 1 lb. on dry beans.
Beans, snap	Eptam	3-4 lb.	Annual grasses and nutgrass[4]	Preplant soil application Incorporate with soil immediately	Use 3-pound rate on light sandy soil. Do not feed foliage to livestock.
	Treflan	0.5-0.75 lb.	Annuals[2]	Preplant soil application Incorporate with soil immediately	Plant crop immediately or within 3 weeks after application.
Beets, garden and sugar	Pyramin	4 lb.	Annuals	Preemergence or after beets emerge and before weeds have 2 true leaves	Where grasses are a severe problem, use 4 lb. Pyramin +4-6 lb. TCA.
	TCA	8 lb.	Annual grasses	Preemergence	Do not use treated tops for food.
Broccoli Brussels sprouts Cabbage Cauliflower	Treflan	0.5-1 lb.	Annuals[2]	Preplant soil application Incorporate with soil immediately	Transplant after application to 3 weeks later.
Broccoli Cabbage Cauliflower	TOK[7]	3-5 lb.	Annuals[8]	One to 2 weeks after crop emergence or transplanting, while weeds are in seedling stage	
Carrots Celery Dill Parsnips Parsley	Stoddard Solvent	60-80 gal.	Annuals	After 2 true leaves have appeared (do not apply to carrots or parsnips after they are ¼ inch diameter, since oily taste may result)	Most effective when sprayed on cloudy days or during high humidity, and when weeds are not more than 2 inches high. May not control ragweed.
Carrots Celery Parsley	TOK	3-5 lb.	Annuals[8]	While weeds are in seedling stage	
Carrots	Treflan	0.5-1.0 lb.	Annuals[2]	Preplant soil incorporation Incorporate with soil immediately	Seed after application to 3 weeks later.
Carrots Parsnips	Lorox	2 lb. 1½ lb.	Annuals	Preemergence	Do not feed treated foliage to livestock or replant treated area for 4 months. Do not use on parsnips on sandy soil. Use ⅔ rate on carrots on sandy soil.
Cucumbers Muskmelons Watermelon	Alanap	3-5 lb.	Annuals[4]	Immediately after seeding or transplanting	Do not use on cold soil. Rainfall or irrigation after treatment gives maximum control.
		3-3.5 lb.		After transplanting or vining	Use granular form. Keep away from foliage.
	Prefar	4-6 lb.	Annuals	Preplant soil incorporation Incorporate with soil immediately	Is primarily a grass killer. May not control lambsquarter. Consult label for sensitive crops within 18 months after application. Do not use in double cropping when followed by snap beans the same growing season.
	Prefar plus Alanap	3-4 lb. +2-3 lb.	Annuals	Preplant soil incorporation for Prefar; Alanap as an immediate post seeding application	FOR TRIAL USE ONLY IN 1969. Should have value for broad spectrum weed control in cucumbers for mechanical harvest. Consult label for sensitive crops within 18 months after Prefar application.
Lettuce	Balan	1.25 lb.	Annuals	Preplant soil incorporation Incorporate with soil immediately	Is primarily a grass killer. Seed after application to 3 weeks later. Do not plant wheat, barley, rye, grass, onions, oats, beets, or spinach for 12 months after application.

[1] Based on active ingredients (actual amount of active herbicide in material or acid equivalent). Use lower rate on sandy soil and higher rate on clay and loam soils. When using a band application over the row, adjust amount of material applied to the part of an acre treated. See Illinois Circular 791.
[2] May not control ragweed. [3] May not control ragweed, smartweed, and velvetleaf. [4] May not control smartweed. [5] May not control smartweed and velvetleaf. [6] May not control crabgrass. [7] Use of 50% wettable powder is suggested for cabbage. [8] May not control ragweed or chickweed. Grass control is sometimes marginal.

Crop	Herbicide	Rate of active ingredient per acre actually covered[1]	Weeds controlled	Best time of application (based on crop stage)	Remarks, cautions, limitations
Onions	Dacthal	8-10 lb.	Annuals[3]	Immediately after seeding or transplanting	May not kill smartweed or common ragweed. Can be used on seeds, sets, or seedlings. CIPC can be used for smartweed or common ragweed.
	Chloro-IPC	3-6 lb.	Use to enhance broad leaf control (especially smartweed)	On seeded onions: loop stage or after 3- to 4-leaf stage	In the later sprays, direct at base of onion plant. If more than one application is applied do not exceed 6 lb. per acre for the season. *Use lower rates in cool, wet weather.* Use no later than 30 days before harvest.
	Randox	4-6 lb.	Annuals[5]	After 3 or more true leaves	Heavy rainfall may reduce stand. Very effective on purslane and pigweed. Use no later than 45 days before harvest. Direct application to base of plant in later treatment.
Peas	Treflan	0.5-0.75 lb.	Annuals[2]	Preplant soil incorporation Incorporate with soil immediately	Seed after application to 3 weeks later.
	MCPB	1 lb.	Broad-leaved weeds and Canada thistle	When peas are 3-7 inches tall and no later than 4 nodes prior to pea blossom	May delay maturity 1 to 4 days. Use at least 20 gal. of water per acre. Do not feed vines to livestock. MCPA is more effective on mustard. MCPB is less injurious to peas.
	MCPA	¼-½ lb.			
Peppers	Dymid, Enide	4-5 lb.	Annuals	Preemergence or after transplanting	Do not plant another food crop on treated areas for 6 months. Use 4 lb. on light soil.
	Vegiben	3-4 lb.	Annuals	Within 2 to 3 days after transplanting or immediately after lay-by	Apply only once during growing season. Apply when foliage is dry. Rainfall or irrigation after application will give best results. Use granular formulation only. Do not feed foliage to livestock.
	Treflan	0.5-1 lb.	Annuals[2]	Preplant soil application Incorporate with soil immediately	Use on transplants only.
Potatoes, Irish	Eptam	3-5 lb.	Annual grasses and nutgrass[4]	Preplant soil application Incorporate with soil immediately	Use lower rate on sandy soil.
	Lorox	1-2 lb.	Annuals	Preemergence or at very start of potato emergence	Use 1 lb. rate on light sandy soil. Plant tubers at least 2 inches deep. Do not replant treated area to other crops for 4 months after treatment.
	Treflan	0.5-1.0 lb.	Annuals[2]	Preemergence to potatoes as a dragoff treatment	Must be incorporated into soil, but do not incorporate to a depth to injure planted tubers.
	Dowpon	6 lb.	Quackgrass	Before plowing in spring; wait 4 days before plowing and planting	Not for fields intended for red-skinned varieties.
Potatoes, sweet	Dacthal	8-10 lb.	Annuals[3]	Immediately after planting	May not control smartweed or common ragweed. Preferred on sandy soils.
	Amiben	3 lb.	Annuals	Immediately after planting	Preferred on loam soils. Do not feed foliage to livestock.
Spinach	Chloro-IPC	1-3 lb.	Annuals	Immediately after seeding	Use 1 lb. if the temperature is below 60°.
Squash Pumpkins	Alanap	3-3.5 lb.	Annuals[4]	Immediately after seeding	Use granular form on transplants. Do not use early when soil is cold. Moisture is necessary for good control. Use 3-lb. rate on sandy soils.
	Amiben	3-4 lb.	Annuals	As soon after seeding as possible	Use on loam soils.
Summer squash	Prefar	4-6 lb.	Annuals	Preplant soil application Incorporate with soil immediately	Is primarily a grass killer. May not control lambsquarter. Consult label for sensitive crops within 18 months after application.
Sweet corn	Aatrex	2-3 lb.	Annuals, annual and perennial grasses[6]	Preemergence; apply no later than 3 weeks after seeding Shallow cultivation may improve weed control during dry weather	Grow corn a second year without treatment. This chemical has a high soil residue. Do not plant other vegetable crops on a sprayed area until a second year of corn has been grown. Use Atrazine only where quackgrass is a problem. Residue hazard decreased when banded or in combination with Ramrod.
	Ramrod	4 lb.	Annuals	Preemergence	
	Aatrex plus Ramrod	1.5 lb. +2.5 lb.	Annuals and perennial grasses	Preemergence	Use to reduce Atrazine residue.
	Sutan plus Aatrex	3 lb. +1 lb.	Annuals	Preplant soil incorporation Incorporate with soil immediately	FOR TRIAL USE ONLY IN 1969. Use where nutgrass is a problem.
	2,4-D (amine)	½ lb.	Annuals	Postemergence	Preferably, apply before corn is 6 inches tall. If corn is over 12 inches reduce rate to ¼ lb.
Tomatoes, direct-seeded	Dymid, Enide	4-6 lb.	Annuals	Preemergence	Do not plant other food crops on treated areas for 6 months.
	Tillam	4 lb.	Annuals	Preplant soil incorporation Use a 2-4 inch incorporation	Direct seed as soon after application as possible.

(See footnotes on page 2.)

Crop	Herbicide	Rate of active ingredient per acre actually covered[1]	Weeds controlled	Best time of application (based on crop stage)	Remarks, cautions, limitations
Tomatoes, transplanted	Dymid, Enide	4-6 lb.	Annuals	After transplanting	Do not plant other food crops on treated areas for 6 months. Use 4 lb. on light soils.
	Vegiben	3-4 lb.	Annuals	Within 2 days after transplanting	Use granular formulation only. Do not use on sandy soils.
	Treflan	0.5-1 lb.	Annuals[2]	Preplant soil application Incorporate with soil immediately	Some reduction of growth may be possible under growth stress conditions.

(See footnotes on page 2.)

CALIBRATION OF APPLICATION EQUIPMENT

Accurate calibration and uniform coverage are essential for desirable and economical results.

Spray Equipment

The pressure at which the spray is applied is critical and should be in the range of 20 to 60 pounds per square inch. Higher pressures, such as those frequently used in applying other pesticides, are unsatisfactory.

A rate of 40 to 60 gallons per acre would be a good range for liquid application. The amount of herbicide per acre, however, must be controlled closely by careful calibration.

University of Illinois Circular 837, "Calibrating and Maintaining Spray Equipment," provides detailed information on calibrating spray equipment.

Granular Equipment

Check application rate when changing materials and with changes of weather as flow rate may vary between morning and afternoon. University of Illinois Circular 839, "Calibrating and Adjusting Granular Row Applicators," supplies additional details on calibration of granular applicators.

CLEANING OF APPLICATION EQUIPMENT

Spray Equipment

It is important to keep spraying equipment clean to avoid crop contamination or injury and to preserve the equipment. It is recommended that sprayers used for 2,4-D or like compounds *not* be used for applying insecticides, fungicides, or other postemergence herbicides on other crops. When cleaning a sprayer, thoroughly wash the tank, pump, lines, boom, and nozzles. The spray pump should be in operation to insure circulation of the cleaning solution throughout the sprayer. Water will rinse out many preemergence materials, but persistent herbicides require the use of cleaning agents. The addition of one gallon of household ammonia or 5 pounds of sal soda to 100 gallons of water will aid in removing herbicide residues from sprayers.

Copper residues from fungicides may reduce the effectiveness of certain herbicides, particularly the dinitros. To remove copper residues, add one gallon of vinegar or 5 percent acetic acid to every 100 gallons of water, and let it stand in the sprayer for *two hours only*. Drain the sprayer immediately and rinse thoroughly with water.

Granular Equipment

Granular equipment is easier to clean and maintain than spray equipment. The units should be removed and dumped, or run in an open position and cleaned with forced air. A good tire pump will do the job. Rotate the delivery mechanism to insure adequate removal of granular particles. Store in a dry place when not in use.

Urbana, Illinois December, 1968

Cooperative Extension Work, University of Illinois, College of Agriculture, and the U.S. Department of Agriculture cooperating. JOHN B. CLAAR, Director. Acts approved by Congress May 8 and June 30, 1914. 6M—12-68—99207

1969 WEED CONTROL GUIDE

This guide for using weed-control chemicals is based on research results at the University of Illinois Agricultural Experiment Station, other experiment stations, and the U.S. Department of Agriculture. Although not all herbicides commercially available are mentioned, an attempt has been made to include materials that were tested and showed promise for controlling weeds in Illinois. Consideration was given to the soils, crops, and weed problems of the state.

The field of chemical weed control is still relatively new. The herbicides now available are not perfect. Factors such as rainfall, soil type, and method of application influence their effectiveness. Under certain conditions some herbicides may damage the crops to which they are applied. In some cases chemical residues in the soil may damage crops grown later.

When deciding whether to use a herbicide, consider both the risk involved in using the herbicide and the yield losses caused by weeds. If you do not have much of a weed problem and if cultivation and other good cultural practices are adequate for control, do not use herbicides. If you do use herbicides, be willing to assume the risks involved. Much of the risk can be decreased by following these precautions:

- Use herbicides only on those crops for which they are specifically approved and recommended.
- Use no more than recommended amounts. Applying too much herbicide may damage crops, may be unsafe if a crop is to be used for food or feed, and is costly.
- Apply herbicides only at times specified on the label. Observe the recommended intervals between treatment and pasturing or harvesting of crops.
- Wear goggles, rubber gloves, and other protective clothing as suggested by the label.
- Guard against possible injury to nearby susceptible plants. Droplets of 2,4-D, MCPA, 2,4,5-T, and dicamba sprays often drift for several hundred yards. Take care to prevent damage to such susceptible crops as soybeans, grapes, and tomatoes. If it is necessary to spray in the vicinity of such crops, the amine form is safer to use than the volatile ester form. But even with the amine form, spray may drift to susceptible crops. To reduce chance of damage, operate sprayers at low pressure with tips that deliver large droplets and high gallonage output. Some farm liability insurance policies do not cover crop damage caused by the ester form of 2,4-D. Spray only on a calm day or make sure air is not moving toward susceptible crop plants and ornamentals.
- Apply herbicides only when all animals and persons not directly involved in the application have been removed. Avoid unnecessary exposure.
- Return unused herbicides to a safe storage place promptly. Store them in original containers, away from unauthorized persons, particularly children.

Since manufacturers' formulations and labels are sometimes changed and government regulations modified, always refer to the most recent product label for specific information.

This guide is provided for your information. The University of Illinois and its agents assume no responsibility for results from using herbicides, whether they are used according to the suggestions, recommendations, or directions of the manufacturer or any governmental agency.

Names of Some Herbicides

Common	Trade
Amiben	Amiben
Amitrole	Amino triazole, Weedazol
Amitrole-T	Cytrol, Amitrol-T
Ammonium sulfamate	Ammate-X
Atrazine	Atrazine
Bromoxynil	Brominil, Buctril
Butylate	Sutan
CDAA	Randox
CDAA-T	Randox-T
CIPC	Chloro IPC
Chloroxuron	Tenoran
Dalapon	Dowpon
DCPA	Dacthal
Dicamba	Banvel-D
Dinitro (DNBP)	(Several)
Diphenamid	Dymid, Enide
EPTC	Eptam
EPTC plus 2,4-D	Knoxweed
Fenuron	Dybar
Fenuron TCA	Urab
Linuron	Lorox
MCPA	(Several)
Monuron	Telvar
Monuron TCA	Urox
Norea	Herban
NPA	Alanap
Picloram	Tordon
Prometryne plus atrazine	Primaze
Propachlor	Ramrod
Propachlor plus linuron	Londax
Propazine	Propazine
Nitralin	Planavin
Simazine	Simazine

Prepared by Ellery Knake, associate professor of weed science, M. D. McGlamery, assistant professor of agronomy, and F. W. Slife, professor of crop production. Reprinted from ILLINOIS AGRONOMY HANDBOOK for 1969. Cooperative Extension Work, University of Illinois, College of Agriculture, and the U.S. Department of Agriculture cooperating. JOHN B. CLAAR, director. Acts approved by Congress May 8 and June 30, 1914.

Sodium chlorate .... (Several)
Sodium chlorate plus calcium chloride........Atlacide
Trifluralin................................Treflan
Vernolate..................................Vernam
2,4-D ....(Several)
2,4,5-T...............................(Several)
2,4-DB................Butoxone, Butyrac, and others

For clarity, trade names have been used frequently. This is not intended to discriminate against similar products not mentioned by trade names.

Corn

For most effective weed control in corn, plan a program well in advance of planting that includes both cultural practices and herbicide applications. If weeds are not a serious problem, cultural practices alone are sometimes adequate. Prepare seedbeds well enough to kill existing weed growth and provide favorable conditions for germination and early growth of corn. Working the soil several times is not essential if weeds can be destroyed well enough during final seedbed preparation. Working the seedbed excessively may intensify the weed problem and may contribute to crusting. A relatively high plant population and perhaps narrow rows provide effective shading to discourage weed growth.

Early cultivations are most effective for killing weeds. The rotary hoe or harrow works best if used after weed seeds have germinated and before or as soon as the weeds appear above the soil surface. Use row cultivators while the weeds are still very small. Set the shovels for shallow cultivation to prevent root pruning and to bring fewer weed seeds to the surface. However, enough soil should be thrown into the row to smother weeds. Where you use a preemergence herbicide, if it is not sufficiently effective, cultivate with the rotary hoe or row cultivator while the weeds are still small enough to control.

Even where herbicides are used, most farmers still use a rotary hoe or harrow for an early cultivation, followed by one or two row cultivations as needed. Some farmers, especially those with narrow rows, high populations, and large acreages, are broadcasting herbicides and are sometimes eliminating cultivation if control is adequate. Research indicates that if weed control is adequate and the soil is not crusted because of excessive seedbed preparation or other factors, there usually is little or no benefit from cultivation on most Illinois soils. Weigh the added expense of broadcasting herbicides against other factors, such as time saved at a critical season.

The use of preemergence herbicides has increased rapidly from 5 percent of the corn acreage treated in 1960 to over half treated in 1968. Their popularity is partly caused by the need for improved control of weeds, especially annual grasses which became more severe as farmers switched from checking to drilling and hill-dropping corn. Preemergence herbicides also offer a relatively convenient and economical means of providing early weed control and they allow faster cultivation.

Most preemergence herbicides are applied as the crop is planted. However, you may apply some preplant (before planting) and some after planting. You can mix some with other agricultural chemicals for application. You can apply some to the surface, but must incorporate others into the soil. You can apply some either way.

Plan well in advance to select a weed-control program that is most appropriate for your soil, crops, weed problems, farming operations, and personal desires. Be prepared to modify your plans as required during the season.

Preemergence Herbicides Applied at Planting

Preferred

Atrazine is one of the most popular herbicides for corn. It controls both broad-leaved and grass weeds, but is particularly effective on many broadleaves such as smartweed. Corn has very good tolerance to preemergence applications of Atrazine. It is most effective on the light soils that are relatively low in organic matter, but is also effective on soils with more organic matter if the rate is increased. Don't exceed the rates specified on the label, however. For help in selecting Atrazine rates on the basis of organic matter content of the soil refer to Table 1 on page 9.

Atrazine will often persist long enough to give weed control for most of the season. But unless you take proper precautions, enough Atrazine may remain in the soil to damage some crops the following season. Where Atrazine is applied in the spring, do not follow that fall or the next spring with small grains, small seeded legumes, or vegetables. If Atrazine 80W is used at a broadcast rate above 3¾ pounds per acre (or comparable rates in a band) do not plant any crop except corn or sorghum the next growing season.

Soybeans planted where Atrazine was used the previous year may show some effect, especially if more than the recommended amount was used or on ends of fields where some areas received excessive amounts. Applying Atrazine relatively late the previous year and planting soybeans early allows less time for loss of Atrazine residue and increases the possibility of injury to soybeans. Minimizing tillage before planting soybeans also increases the possibility of Atrazine residue affecting soybeans.

You can use Atrazine on most types of corn, including field corn, silage corn, seed-production fields, sweet corn, and popcorn. For use on corn, Atrazine is available from the manufacturer only as a wettable powder for spray application. Mix adequately, provide adequate agitation, and follow other precautions on the label to assure uniform application.

Ramrod (propachlor) has given very good control of annual grass weeds, often giving better initial control and usually a little longer control than Randox. It has also controlled pigweed and given fair control of lambsquarter. Ramrod performs best on soils above 3 percent organic matter.

Most of the commonly grown corn hybrids have good tolerance to Ramrod. It is cleared for field corn, silage corn, hybrid seed-production fields, and sweet corn.

Ramrod is available as a 65-percent wettable powder and as 20-percent granules. Ramrod is not as irritating to handle as Randox, but take precautions to avoid irritation to skin and eyes. Some individuals are more sensitive than others.

A good program is to use Ramrod either as a spray or as granules at planting time to control annual grass weeds and follow with an early postemergence application of 2,4-D to control broad-leaved weeds.

Ramrod plus Atrazine, each at a reduced rate, controls both annual broad-leaved and grass weeds. This combination has given good weed control in research and field trials. For the combination, 4½ pounds of Ramrod 65-percent wettable powder is suggested, regardless of soil type. The amount of Atrazine to add will vary with soil type — 1¼ pounds of Atrazine 80-percent wettable powder for the light-colored soils that are low in organic matter and 2 pounds for the darker soils. The reduced rate of Atrazine will control many broad-leaved weeds, such as smartweed, but may be marginal for control of some like velvetleaf. The reduced rate of Ramrod is adequate for control of most annual grasses. The mixture controls broad-leaved weeds better than Ramrod alone and often controls annual grass weeds better than Atrazine alone. It reduces the Atrazine residue problem, and gives more consistent control on the darker soils or with limited rainfall than Atrazine alone.

Randox (CDAA) is approved for field corn, hybrid seed corn, sweet corn, and popcorn. It is adapted primarily to the darker soils with moderate to high organic matter. Do not use Randox on sandy soils. It controls annual grass weeds and pigweed for about four weeks. Preemergence application of Randox can be followed with early postemergence application of 2,4-D to improve broad-leaved weed control. Most Randox is used in granular form to reduce irritation. But even with granules, be careful to avoid irritation to skin and eyes.

Lasso (CP50144) is a new herbicide for corn, and possibly for soybeans, which has looked promising in research trials. Lasso is similar in some respects to Ramrod. If label clearance is obtained for 1969 it will be available as liquid concentrate and as granules.

Lasso controls about the same weeds as Ramrod, but since Lasso is more active than Ramrod, less Lasso per acre is needed. Lasso is less soluble than Ramrod. With limited rainfall Ramrod may sometimes perform slightly better than Lasso. Lasso looks promising for nutsedge (nutgrass) control but results may be somewhat erratic. Irritation from Lasso appears to be less than with Ramrod.

Less Preferred

Because of greater possibility of crop injury or less weed control, the following preemergence herbicides for corn are not considered as satisfactory as those discussed above.

Knoxweed is a combination of Eptam (EPTC) and 2,4-D. It is cleared for use on field corn, sweet corn, and silage corn. Do not use it on seed-production fields. Knoxweed has given rather erratic weed control, depending on rainfall and soil moisture. More consistent weed control is likely when rain occurs soon after application. The possibility of corn injury from Knoxweed has not been a serious problem but does exist. Knoxweed has presented no hazard to crops the next season. It is available in both liquid and granular forms. Do not use on peats, mucks, or sands.

2,4-D ester preemergence for corn controls broad-leaved weeds and gives some control of grass weeds. Weed control is rather erratic. There is some chance of injury to the corn. Use only the ester form for preemergence, since the amine form is more subject to leaching. 2,4-D ester is available in both liquid and granular forms.

A combination of **Atrazine plus Lorox (linuron)** has been available as a prepackaged, wettable-powder mixture or you can "tank-mix" it on the farm for preemergence use on field corn. Especially on the relatively light-colored soils with low organic matter this combination has often given satisfactory weed control. Using a reduced rate of Lorox in the combination reduces, *but does not eliminate,* the possibility of corn injury. Do not use the combination containing Lorox on sandy soils or injury may result.

Primaze is a combination of Atrazine and another triazine compound, prometryne. Although weed control from this combination has been fairly good, *there is increased chance of corn injury with prometryne* in the combination. This combination was introduced commercially in hopes of reducing the Atrazine residue problem. Information on residue from prometryne under Illinois conditions is very meager.

Londax, a combination of Lorox and Ramrod, has clearance for use on corn for grain. It contains Lorox and Ramrod in a ratio of 1 to 2 parts respectively of active ingredient. This combination has given relatively good weed control in research trials. Control of broad-leaved weeds is better than with Ramrod alone. However, the addition of Lorox increases the chance of crop injury.

Randox-T (CDAA-T) is cleared for field corn, silage corn, sweet corn, and popcorn. It occasionally causes injury to corn and the "T" part may carry over in the soil occasionally to cause injury to soybeans the following season. Like Randox it is irritating to handle, so most of it is used in granular form. Take appropriate precautions when handling.

Randox-T controls broad-leaved weeds a little better than Randox. However, a preferred alternative would be to use Ramrod or Randox for control of annual grass weeds and follow with an early postemergence application of 2,4-D for broad-leaved weed control.

Roundup is a combination of Ramrod and 2,4-D. It is available as a wettable powder or in granular form. It has given reasonably good early weed control. Although there is some chance of injury to corn from the 2,4-D, this has not presented a serious problem.

Banvel-D (**dicamba**), **Amiben,** and **Lorox** (**linuron**) each have label clearance for preemergence use on corn, but the risk of corn injury is considered too great to recommend their use for this purpose in Illinois.

Preplant Herbicides for Corn

Recent research and field experience indicate the feasibility of applying some herbicides prior to planting where you wish to commit yourself to broadcast application.

Preplant-incorporated applications offer an opportunity for applying herbicide, insecticide, and fertilizer at the same time if the chemicals are compatible, and if the incorporation gives the proper placement for each chemical.

Preplant applications offer an opportunity to make some herbicide applications before the busy planting season. This could be particularly advantageous for custom applicators and for farmers with large acreages. It would allow fewer attachments on the planter. However, the weather will often dictate the actual time for application, so where preplant applications are planned you should also have an alternate plan in case preplant applications are not possible.

Atrazine is the major preemergence corn herbicide currently available for preplant application. Although early spring and even fall applications have been tried, research indicates that for corn, the closer to planting time Atrazine is applied, the more successful the application is likely to be. Make applications no earlier than two weeks before planting.

Apply Atrazine to the soil surface or incorporate it lightly with a shallow disking or similar operation. The field cultivator has been successfully used for incorporation, but results have not always been quite as good as with a disk. Depth and thoroughness of incorporation will depend on many factors, such as type of equipment, depth of operation and other adjustments, speed, soil texture, and soil physical condition when incorporating.

With so many factors involved, exact specifications for incorporation cannot be given. However, one principle to keep in mind is that the deeper the herbicide is incorporated and the more soil it is mixed with, the more dilute it will be. With excessive incorporation and dilution the effectiveness of the herbicide may be decreased. As a rule of thumb, incorporation devices such as a disk usually move the herbicide only to about a third to half the depth at which the implement is operated.

The major reason for incorporating some herbicides is to reduce loss of herbicide from the soil surface. Since loss of Atrazine is not very rapid, incorporation is not essential. Another advantage for incorporating some herbicides may be moving herbicide into soil where there is sufficient moisture for weeds to absorb it.

Atrazine is very effective for control of many broad-leaved weeds and is often quite satisfactory for control of annual grass weeds. However, under unfavorable conditions it may not adequately control some annual grasses such as giant foxtail, crabgrass, and panicum. Considerable research has been done attempting to find another herbicide that could be combined with Atrazine to improve grass control.

Atrazine plus Sutan (**butylate**) has been one of the most promising combinations tested for incorporation before planting and is suggested for trial use. Research suggests that other herbicides for possible combination with Atrazine, such as Ramrod and Lorox, often do not maintain their effectiveness sufficiently when incorporated.

If used alone, 3 to 4 pounds of Sutan (active ingredient, broadcast basis) are suggested. If used in combination with Atrazine, 3 pounds of Sutan (½ gallon of commercial product) plus 1¼ pounds of Atrazine 80W are suggested.

Sutan has generally given good control of annual grass weeds and Atrazine controls many broad-leaved weeds even at the reduced rate. Sutan may be used to control Johnsongrass and wild cane and may be helpful to control nutsedge (nutgrass). Corn tolerance with Sutan appears to be marginal and under some conditions occasional injury to corn has been observed.

Postemergence Herbicides for Corn

2,4-D provides one of the most economical and effective treatments for many broad-leaved weeds in corn.

For greatest effectiveness, apply 2,4-D when weeds are small and easiest to kill. You can apply the spray broadcast over the top of the corn and weeds until corn is about 8 inches high. After that height, use drop extensions from the boom down to the nozzles. These "drop nozzles" help keep the 2,4-D off the top of the corn and decrease the possibility of injury. You can direct the nozzles toward the row where most of the weeds will be. However, if you direct the nozzles toward the row, adjust the concentration of the spray so that excessive amounts are not applied to the corn.

Each year some corn is damaged by 2,4-D. It is virtually impossible to eliminate all cases of 2,4-D damage. The chemical usually makes corn brittle for a week or ten days. If struck by a strong wind or by the cultivator, some corn may be broken off. Some stalks may "elbow" or bend near the base. Other symptoms of 2,4-D injury are abnormal brace roots and "onion leafing," a condition in which the upper leaves remain tightly rolled and may delay tassel emergence.

Spraying 2,4-D during very cool, wet weather when corn plants are under stress, or spraying during very hot, humid weather may increase the possibility of corn injury from 2,4-D.

Some inbreds and some hybrids are more easily injured by 2,4-D than others. It is usually best not to use, 2,4-D on inbreds unless you are certain they have a high tolerance. Single crosses may or may not be more sensitive than double crosses, depending on the sensitivity of the inbred parents. Double-cross hybrids and three-way crosses also vary in their sensitivity depending on their genetic makeup.

To help avoid damage to corn, be sure to apply 2,4-D at no more than the recommended rate. The recommended rates per acre for broadcasting are: ⅙ pound of low-volatile ester; ¼ pound of high-volatile ester; or ½ pound of amine.

Here's an easy way to calculate the amount of 2,4-D needed. If using a formulation with 4 pounds of 2,4-D per gallon, each quart will contain 1 pound; each pint ½ pound; and each half-pint ¼ pound. It would take 1 pint of amine formulation to get ½ pound of 2,4-D. A gallon of 2,4-D amine (with 4 pounds of 2,4-D per gallon) would be enough to broadcast 8 acres (4 lb./gal. ÷ ½ lb./A. = 8 acres). A gallon of 2,4-D containing 4 pounds of 2,4-D high-volatile ester would be enough to broadcast 16 acres (4 lb./gal. ÷ ¼ lb./A.= 16 acres).

It is important to spray weeds when they are small and easiest to kill and before they have competed seriously with the crop. However, you can use high-clearance equipment relatively late in the season if you wish, especially for control of late-germinating weeds. Many of the weeds that germinate late are not very competitive with corn, but control would decrease production of weed seeds. Do not apply 2,4-D to corn from tasseling to dough stage.

Esters of 2,4-D are more effective than amines of 2,4-D; therefore, use lower rates of esters than of amines to reduce crop injury. After you adjust rates to allow for this difference in effectiveness on weeds and crops, the results with either amines or esters are usually similar.

Amines are salts that are dissolved to prepare liquid formulations and when mixed with water they form clear solutions. Esters of 2,4-D are formulated in oil and when mixed with water they form milky emulsions.

Dacamine is an amine form of 2,4-D that is formulated in oil and is called an oil-soluble amine. Since it is formulated in oil like the esters it is said to have the effectiveness of the esters, but it retains the low-volatile safety features of the amines.

Emulsamine is a trade name for another oil-soluble amine. The active ingredient in the various formulations of 2,4-D is still 2,4-D and when you adjust rates appropriately to provide both weed control and crop safety the various formulations are usually similar in their effectiveness.

Banvel-D (dicamba) is not usually recommended, but you can use it as a postemergence spray over the top of field corn until corn is 3 feet high. Corn has relatively good tolerance to Banvel-D at the recommended rate of ⅛ to ¼ pound (¼ to ½ pint) per acre on a broadcast basis. Use proportionately less if placed only in the row.

You can mix Banvel-D with ¼ to ½ pound of 2,4-D amine (most 2,4-D esters do not mix well with Banvel-D). Drop nozzles are not necessary with Banvel-D alone, but use them if you mix Banvel-D with 2,4-D and apply it after corn is 8 inches high.

Banvel-D is similar to 2,4-D in some respects, but controls smartweed better than does 2,4-D. *Banvel-D has often affected soybeans in the vicinity of treated corn fields and has presented a much more serious problem than 2,4-D.* Although soybean yields may not always be reduced, they can be if injury is severe enough. Banvel-D can also affect other susceptible broad-leaved plants, such as vegetables and ornamentals.

Do not make more than one postemergence application of Banvel-D per season. You can use Banvel-D on field corn for grain or silage, but do not graze or harvest for dairy feed before the ensilage stage (milk stage). Use extreme care not to allow Banvel-D onto desirable plants either by direct application, from contaminated sprayers, or by movement through the air from treated areas.

Because of the limited advantage of Banvel-D over 2,4-D and the greater risk of injury to other crops in the vicinity, Banvel-D is usually not recommended. If you anticipate a smartweed problem in corn, Atrazine preemergence or very early postemergence usually gives good control with much less risk of injury to other nearby plants.

Atrazine can be applied as an early postemergence spray to corn up to 3 weeks after planting, but before weed seedlings are more than 1½ inches high. Most annual broad-leaved weeds are more susceptible than grass weeds. The addition of 1 to 2 gallons of oil formulated especially for this purpose has generally increased the effectiveness of early postemergence applications of Atrazine. On the relatively light-colored soils of Illinois, a regular preemergence application of Atrazine will likely remain one of the most successful treatments. On the relatively dark soils of the state there is increased interest in the "Atrazine-oil" treatment. Research and field experience suggest that for those relatively dark soils, 2½ pounds of Atrazine 80W plus 1 gallon of oil may sometimes be just as effective initially, and sometimes more effective than a preemergence application of 3¾ pounds of Atrazine 80W.

As with many herbicide applications, the results with Atrazine and oil will be influencd by many factors, and results are not always consistent. Especially for control of annual grasses, it is important to apply early when grasses are small.

The early postemergence application with Atrazine and oil may be of particular help where rainfall is less certain, on the darker soils, and where soil conditions are too wet for cultivation.

Although corn has displayed excellent tolerance to Atrazine alone, corn has sometimes shown a general stunting where oil was added, and there were a few cases of fairly severe injury to corn where Atrazine and oil were used in 1967 and 1968. Weather conditions, stage of growth, rate of growth, genetic differences, and rate of herbicide used with oil seem to be some of the factors involved.

Certain other additives might be used instead of oil to enhance the postemergence activity of Atrazine. The one most widely tested in 1967 and 1968 was Tronic. Although results with Tronic were not quite as consistent as with oil, results were often quite similar. An advantage for Tronic would be the need for handling less volume — 1 pint of Tronic per 25 gallons of spray solution. Based on limited observations, the possibility of injury to corn might be less with Tronic than with oil.

Directed Postemergence Applications for Corn

Directed sprays are sometimes considered for emergency situations when grass weeds become too tall for control with cultivation. By the time help is sought, the weeds are often too large for directed sprays to be very practical or successful. Since present directed sprays cannot be used on small corn, some other means of control must be used early. Early control with only preemergence herbicides and cultivation are often quite adequate, leaving no need for the directed sprays. Since weeds begin competing with corn quite early, place primary emphasis on early control measures, such as use of preemergence herbicides, rotary hoeing, and timely cultivation.

Dowpon (dalapon). Apply as a directed spray when corn is 8 to 20 inches tall from ground to whorl. Direct Dowpon toward the row using the equivalent of 2 pounds of product on a broadcast basis (⅔ pound in a 14-inch band over 40-inch rows). Dowpon is primarily for control of grass weeds, but 2,4-D can be added for control of broad-leaved weeds. If this treatment is used, use extreme caution to keep the Dowpon off the corn plant as much as possible to avoid injury. Do not let spray contact more than the lower half of the stalk and do not direct the spray more than 7 inches above the ground. *Use "leaf lifters."* Other precautions are given on the label. Dowpon does not give a quick kill, but can stunt the grass and reduce formation of weed seeds. Do not use Dowpon on corn grown for seed.

If excessive amounts of Dowpon contact the corn leaves, the chemical can be translocated (moved) inside the plant and may cause stunted and deformed plants, twisted leaves, short ear husks, and abnormal ears. Because of the risk of injury, Dowpon is not usually recommended in Illinois for application to corn.

Lorox (linuron). Apply as a directed spray after corn is at least 15 inches high (to top of free-standing plant), but before weeds are 8 inches tall (preferably not over 5 inches). This height difference may not occur in some fields and when it does it will usually last for only a few days so the application needs to be very timely. Lorox can control both grass and broad-leaved weeds. Cover the weeds with the spray as much as possible, but keep it off the corn as much as possible. Corn leaves that are contacted can be killed and injury may be sufficient to affect yields. Consider this an emergency treatment and if you want to use it refer to the label for further information on rates, addition of a surfactant (wetting agent), and other precautions.

Flame cultivation has been tried as a means of controlling weeds in corn. To obtain satisfactory control, flaming must be started early when weeds are very small and must be repeated whenever new growth appears. Three or four flamings are usually required. To be effective, use flame cultivation as a planned program, not as an emergency measure when weeds are already too tall for control by other means. Flame cultivation does not give good control of tall weeds either.

With other alternatives, such as preemergence herbicides, now available there has been very little acceptance of flame cultivation by Illinois farmers. Flaming requires special equipment and some new skills for proper operation and timing. LP gas for flaming costs approximately the same as banded preemergence herbicides per acre. But flaming requires several more trips over the field.

Soybeans

For soybeans Illinois farmers usually plow the seedbed and use a disk, field cultivator, or similar implement at least once to destroy weed growth and prepare a relatively uniform seedbed for planting. Planting in relatively warm soils helps soybeans begin rapid growth and compete better with weeds. Good weed control during the first 3 to 5 weeks is extremely important. If weed control is adequate during that early period, soybeans usually compete quite well with most of the weeds that begin growth later.

Rotary hoeing is very popular for soybeans, and is used on about three-fourths of the soybean acreage in Illinois. It not only helps control early weeds, but if the soil is crusted, it aids emergence. To be most effective, use the rotary hoe after weed seeds have germinated, but before the majority of weeds have emerged. Operate the rotary hoe at 8 to 12 miles per hour and weight it enough to stir the ground properly. The soil must be moved sufficiently to kill the tiny weeds.

Following one or two rotary hoeings, use the row cultivator one or two times. Adjust the row cultivator properly and operate it fast enough to move soil into the row to smother small weeds. But avoid excessive ridging, which would make harvesting difficult.

It is often said that soybeans in narrow rows provide more shade and compete better with weeds. However, with narrow rows there is more row area where weeds are difficult to control. So a good weed-control program is just as important, or more so, for narrow-row beans.

There is considerable interest in "solid drilling" of soybeans in 7- to 10-inch rows. However, you cannot expect present herbicides to control weeds adequately 100 percent of the time. So for most situations it is preferable to keep the rows wide enough so you can use cultivation as required.

Use of preemergence herbicides for soybeans has increased rapidly from about 5 percent of the Illinois acreage treated in 1960 to about half of the acreage treated in 1968. Whether you should use herbicides for soybeans will depend on the seriousness and nature of your weed problem, as well as your preference for various alternative methods of weed control. Preemergence herbicides are often extremely helpful in obtaining the necessary early control in the row. They can allow a reduction in the number of cultivations, allow faster cultivation, and reduce the amount of ridging needed to smother weeds in the row.

Even though you have used a preemergence herbicide, if it appears doubtful that it will give adequate control, use the rotary hoe while weeds are still small enough to be controlled. Use row cultivation as needed before weeds in the row become too large to be smothered.

When selecting a preemergence herbicide for soybeans consider the kind of weeds likely to be present. Many of the preemergence herbicides for soybeans are particularly effective for controlling annual grasses. The majority give good control of pigweed, and many will also control lambsquarter. Most do not give good control of annual morningglory, and control of velvetleaf, jimsonweed, and cocklebur is rather erratic.

Many of the preemergence herbicides for soybeans may occasionally cause injury to the soybean plants. Fortunately, soybeans usually have the ability to outgrow modest amounts of early injury, and usually the benefits from weed control provided by the herbicide are much greater than any adverse effects from the herbicides. There may occasionally be exceptions and anyone using herbicides should realize there are some risks involved.

Where you use herbicides for soybeans, it is particularly important to use high-quality seed of disease-resistant varieties. Soybeans that are under stress and do not begin vigorous growth appear to be more subject to herbicide injury. And soybeans that are injured by a herbicide are likely to be more subject to disease. Any one of these factors alone may not be too serious, but several of them acting together could be.

Preemergence Applications for Soybeans

Preferred Herbicides

Amiben has been one of the most popular herbicides for soybeans. It controls the majority of annual grass and broad-leaved weeds in soybeans most of the season. The major exception is annual morningglory. Control of velvetleaf, jimsonweed, and cocklebur is somewhat erratic. Amiben occasionally injures soybeans, but damage is usually not very severe. When it occurs, injury appears as malformed roots and stunting of the tops.

Amiben is adapted to a wide range of soil types. The manufacturer recommends 1 to 1½ gallons or 20 to 30 pounds of granules (2 to 3 pounds active ingredient) on a broadcast basis per acre or proportionately less for band application. The higher rate is suggested primarily for heavy clay or high-organic soils. University trials have shown best weed control with 1½ gallons or 30 pounds of granules per acre. If you reduce the rate, weed control may be reduced. Consider the degree of control desired, as well as the cost. You can make a comparison of 1, 1¼, and 1½ gallons (20, 25, and 30 pounds of granules) per acre on a field and use it as a basis for selecting rates for that field in the future. Granules and liquid perform about equally well. Amiben is easy to handle and is usually applied to the soil surface at planting time.

Treflan (trifluralin) is one of the most effective herbicides for controlling annual grasses such as foxtail. It is also the major soybean herbicide suggested for controlling wild cane and Johnsongrass seedlings. Treflan will also control pigweed and give fair control of lambsquarter, but does not give good control of most other broadleaved weeds commonly found in Illinois soybean fields.

Treflan has given satisfactory control of susceptible weeds a high percentage of the time. Soybean injury is possible with Treflan and occasionally may be fairly severe. It may cause tops to be stunted and may cause a reduction in the number of lateral roots in the treated zone. Compared to the advantages of Treflan for controlling annual grasses, the injury from Treflan on a statewide basis is not considered a serious problem. However, in some individual fields where the stand of soybeans is reduced and plants are injured, the problem may be considered significant. Following instructions for rate and method of application are very important in reducing the possibility of injury.

You can apply Treflan just before planting or anytime during 6 weeks before planting. Incorporate it into the soil immediately after application, by using a disk or similar implement to reduce loss from the soil surface. Cross-disk a second time at right angles to the first disking to obtain more uniform distribution. This will help give more uniform weed control and reduce possibility of soybean injury. You can delay the second disking until anytime before planting, and using it for final seedbed preparation just before planting usually improves control.

The disk probably will incorporate the chemical to only ⅓ to ½ the depth of operation. Disking 4 to 6 inches deep to mix the chemical about 2 inches deep is usually considered appropriate. You can use implements other than the disk if they adequately mix the chemical to a depth of about 2 inches. Results with the field cultivator have sometimes been acceptable, but not always as good as with the disk. The degree of incorporation may vary considerably depending on type of implement, adjustment, speed, soil moisture, soil texture, and other soil physical conditions.

The rate of Treflan is between ½ and 1 quart liquid (½ to 1 pound of active ingredient) per acre on a broadcast basis. Select the rate on the basis of soil type as indicated on the label. After determining the organic matter content of your soil by estimation or by laboratory analysis you can use Table 1 as a guide for selecting appropriate rates for most Illinois soils. For most of the light-colored silt loams of Illinois use ½ to ¾ quart per acre; for the dark-colored silt loams, silty clay loams, and clays with over 3 percent organic matter use ¾ to 1 quart per acre.

Treflan is also available in granular form. The granules have not been as thoroughly tested as the liquid, but appear to be comparable in performance.

In 1968 there were a few cases where Treflan residue appeared to have carried over from 1967 to injure corn planted in 1968. In many of these fields the soybean stubble had not been plowed with a moldboard plow. Some areas apparently had excessive applications.

Research also suggests some possibility of Treflan residue affecting small grain. Using no more than recommended rates and making careful applications should reduce, but may not eliminate, the possibility of injury to subsequent crops.

Planavin (nitralin) is similar to Treflan in the kinds of weeds controlled. However, research indicates that in Illinois higher rates of Planavin are needed to provide about the same control obtained with Treflan.

On some of the light-colored silt loams of the southern part of Illinois, ¾ pound per acre of active ingredient of Planavin (¾ quart of liquid or 1 pound of 75-percent wettable powder) appears to be appropriate. Higher rates are needed as organic matter increases. See Table 1.

Planavin is cleared up to 1½ pounds per acre of active ingredient but it does not appear to be well adapted to the darker soils of the northern part of Illinois. Planavin can be applied from 4 weeks before planting to immediately after planting. Incorporate soon after application to a depth of 1 to 1½ inches with a disk operated shallow or similar equipment. Research data at the present time are not adequate to predict fully the potential for Planavin residue affecting subsequent crops but it is anticipated to be similar to Treflan in this respect.

Randox (CDAA) is primarily for control of annual grass weeds on the relatively dark soils. It also controls pigweed. Soybeans have good tolerance to Randox. Since Randox is irritating to handle, most of it is used in granular form. With either liquid or granules be very cautious to avoid irritation to skin and eyes. The suggested rate is 1 gallon of liquid or 20 pounds of granules (4 pounds of active ingredient) per acre on a broadcast basis, or proportionately less for band application. Randox is relatively soluble, so do not use it on sandy soils. Randox may be expected to control weeds about 4 weeks.

Ramrod (propachlor) is more effective for controlling weeds than Randox, performs better on the lighter soils, and is less irritating. Ramrod can provide weed control for about 6 weeks. It is irritating, especially to certain sensitive individuals, so take appropriate precautions in handling. Ramrod is cleared for use on soybeans to be grown and used for seed, but do not use it for soybeans that will be harvested and processed for food, feed, or edible oil purposes unless additional federal clearance is obtained. Ramrod is available as 20-percent granules or as a 65-percent wettable powder. Twenty pounds of the granules or 6 pounds of the wettable powder is equivalent to 4 pounds of active ingredient, which is the recommended rate per acre on a broadcast basis. Proportionately less is suggested for band applications.

Lasso may receive federal clearance before Ramrod for use on soybeans other than seedbeans. If Lasso receives clearance it may be promoted more for soybeans than for corn in 1969. Soybeans appear to have relatively good tolerance to Lasso. See the discussion of corn for additional information on Lasso.

Less Preferred Herbicides

Because of the greater possibility of crop injury or less weed control, the following preemergence herbicides for soybeans are not considered as satisfactory as those previously discussed.

Lorox (linuron) has given relatively good weed control in soybeans, particularly on the light-colored silt loams. However, the margin of selectivity between dependable weed control and crop damage is rather narrow. Lorox performance is affected considerably by organic matter content of the soil. For suggested rates see Table 1.

Selecting rates on the basis of organic matter and making careful applications will reduce, but may not eliminate, the possibility of crop injury. Do not use Lorox on sandy soils because of the risk of crop injury.

Alanap Plus (NPA plus CIPC). This combination has replaced most of the straight Alanap formerly used in Illinois. Although sometimes satisfactory, weed control from Alanap alone or combined with CIPC has been rather erratic. Crop injury can occur with either one of these herbicides alone or in combination. Under favorable conditions, Alanap Plus can control annual grasses, smartweed, ragweed, velvetleaf, and jimsonweed. Alanap Plus is used at the rate of 1½ gallons of liquid or 40 pounds of granules per acre on a broadcast basis, or proportionately less when banded. This is equivalent to 3 pounds of NPA and 2 pounds of CIPC active ingredients broadcast per acre.

CIPC has not commonly been used in Illinois, except in combination with other herbicides. When tested alone, rates of CIPC sufficient to give adequate control of most weeds have sometimes caused soybean injury. However, smartweed is particularly sensitive to CIPC. For controlling smartweed in soybeans, 3 pounds per acre of CIPC active ingredient on a broadcast basis may be used. This reduced rate of CIPC can be used alone or possibly in combination with some other herbicides that are weak on smartweed.

Vernam (vernolate) has given good control of annual grass weeds in Illinois trials, but injury to soybeans sometimes occurs. Vernam might be considered for serious infestations of wild cane and for control of Johnsongrass seedlings where some soybean injury from the herbicide might be tolerated. Vernam may be applied after planting. But when sprayed, it requires shallow incorporation with a rotary hoe or similar implement to a depth of about 1½ inches. Incorporation of granules is not essential but usually improves control, especially if rainfall is delayed. In addition to annual grasses, Vernam controls pigweed, lambsquarter, and may give some control of annual morningglory. Rates of active ingredient suggested vary from 2 to 3 pounds per acre depending on soil type, formulation, and method of application.

Dacthal has been used primarily for vegetable crops but is also cleared for soybeans. Soybean tolerance is relatively good. Dacthal is primarily for control of annual grass weeds and pigweed.

Although sometimes satisfactory, weed control has been somewhat erratic, depending on rainfall conditions. Dacthal is sometimes incorporated shallow but incorporation is not essential. Depending on soil type and weed species, the suggested rates vary from 8 to 14 pounds of the 75-percent wettable powder per acre on a broadcast basis or proportionately less in a band.

Postemergence Applications for Soybeans

Tenoran (chloroxuron). Apply Tenoran at the rate of 2 to 3 pounds of the 50-percent wettable powder per acre with 1 pint of Adjuvan T surfactant added per 25 gallons of spray solution. This is the broadcast rate, but you can use proportionately less spray solution for banding. Apply when broad-leaved weeds are less than 1 to 2 inches high and grass weeds no more than ½ inch high. Under favorable conditions Tenoran may give fairly good control of pigweed, lambsquarter, smartweed, jimsonweed, morningglory, and cocklebur. Velvetleaf is more difficult to control and should be not over 1 inch when you treat it. Although intended primarily for control of broad-leaved weeds, Tenoran may give some control of grass if you apply it under favorable conditions when grass weeds are very small.

The major interest in Tenoran would be as a possible control for some of the broad-leaved weeds where a preemergence herbicide such as Treflan had been used preemergence. Control with Tenoran has been somewhat erratic and soybeans are usually injured at rates required for weed control. Injury to soybeans from Tenoran may not necessarily be reflected in final yields.

2,4-DB is sold under several trade names including Butoxone SB and Butyrac 175. This herbicide may be broadcast from 10 days before soybeans begin to bloom until midbloom or as a postemergence directed spray when soybeans are 8 to 12 inches tall and cockleburs are 3 inches tall. Consider this herbicide for emergency situations where cocklebur is quite serious (as in some bottomland areas). The chemical may also give fairly good control of annual morningglory and giant ragweed. But do not expect good control of most other weeds found in Illinois soybean fields. Soybeans may show early wilting followed by later curving of the stems. Some cracking of stems and some proliferated growth may occur at the base of the plants. Lodging may be increased and if excessive rates are applied or unfavorable conditions exist near time of treatment, yields may be lowered. Carefully follow application rates specified on the label.

Fencerow Control

If the vegetation in fencerows consists primarily of broad-leaved weeds, use 2,4-D at the rate of ½ to 1 pound applied in 10 or more gallons of water per acre. Two miles of fencerow, four feet wide is equivalent to about an acre.

Make the first application of 2,4-D in May or early June to control early weeds, and make another application in July or early August to control late weeds.

If the fencerow vegetation consists chiefly of woody plants, use a mixture of 2,4-D and 2,4,5-T.

If there are grass weeds such as Johnsongrass or foxtail in the fencerow, you may mix Dowpon (dalapon) with 2,4-D for control of both broad-leaved weeds and grasses. Spray grasses before seed heads form. Use only 2,4-D where the fencerow vegetation consists primarily of broad-leaved weeds and desirable grasses.

Additional Information

Readers who want additional information on weed control may obtain single copies of the following publications from the University of Illinois, College of Agriculture, Urbana 61801 or from a county extension adviser.

Weeds of the North Central States. Circular 718. ($1.00)

Band Spraying Preemergence Herbicides. Circular 791.

Prevent 2,4-D Injury to Crops and Ornamental Plants. Circular 808.

Controlling Johnsongrass in Illinois. Circular 827.

Controlling Giant Foxtail in Illinois. Circular 828.

Controlling Quackgrass in Illinois. Circular 892.

Calibrating and Maintaining Spray Equipment. Circular 837.

Calibrating and Adjusting Granular Row Applicators. Circular 839.

Controlling Poison Ivy. Circular 850.

Using Preemergence Herbicides. Circular 932.

Color Chart for Estimating Organic Matter in Mineral Soils in Illinois. AG-1941.

Herbicide Application Rates

The performance of some herbicides is influenced considerably by the organic matter content of soil. You can estimate the organic matter content of most Illinois soils by using the "Color Chart for Estimating Organic Matter in Mineral Soils in Illinois" (AG-1941) available from your county extension adviser or the Publications Office, University of Illinois, College of Agriculture, Urbana, Illinois 61801. If a more precise determination of organic matter is desired, a laboratory analysis is suggested.

After you know the approximate organic matter content of soil, Table 1 can be used for selecting appropri-

Table 1. — Suggested Herbicide Rates for Illinois Soils

Percent organic matter	Pounds of active ingredient per acre on a broadcast basis			
	Atrazine	Treflan	Lorox	Planavin
1	.8	½	½	¾
2	1.6	⅔	1	1
3	2.4	¾	1½	1⅛
4	3.2[b]	1	2	1½
5+	4.0[a, b]	1	3[a]	1½[a]

Percent organic matter	Commercial formulation per acre on a broadcast basis			
	Atrazine 80% wettable powder	Treflan liquid (4 lb./gal.)	Lorox 50% wettable powder	Planavin liquid (4 lb./gal.)
	pounds	*quarts*	*pounds*	*quarts*
1	1	½	1	¾
2	2	⅔	2	1
3	3	¾	3	1⅛
4	4[b]	1	4	1½
5+	5[a, b]	1	6[a]	1½[a]

[a] Since results are variable on soils with 5 percent or more organic matter, consider another herbicide or a herbicide combination. Rates indicated for 5 percent or more organic matter are the maximum rates cleared.
[b] If more than 3 pounds per acre active Atrazine are used, do not follow with any crop except corn or sorghum the next growing season.

ate herbicide rates. Using this guide should help you select rates that will provide adequate weed control and minimize herbicide residue.

Table 2 lists the amount of commercial herbicides to apply per acre for liquids or granules, either broadcast or banded.

Here is a guide for calculating the amount of herbicide needed for spraying bands for various row spacings:

Row spacing (inches)	Width of band (inches)	Percent of total area covered
20	12	60
20	14	70
24	12	50
28	14	50
30	12	40
30	15	50
36	12	33
38–40	13	33
42	14	33

Formula for other situations: band width ÷ row spacing = percent of area covered.

Table 2. — Amount of Commercial Product To Apply per Acre

Herbicide	12- to 14-inch bands over 40-inch rows		Broadcast	
	Liquid[a]	Granules[b]	Liquid[a]	Granules[b]
		Corn		
Atrazine	5/6 to 1¼ lb.	......	2½-3¾ lb.	....
Randox	1⅓ qt.	7 lb. (20%)	1 gal.	20 lb.
Ramrod	2 lb.	7 lb. (20%)	6 lb.	20 lb.
Randox-T	1½ qt.	10 lb. (35%)	4½ qt.	30 lb.
Roundup	2 lb.	7 lb. (20%)	6 lb.	20 lb.
Knoxweed	1⅓ pt.	7 lb. (14%)	2 qt.	20 lb.
2,4-D ester	1 pt.[c]	3⅓ lb. (20%)	1½ qt.[c]	10 lb.
Eptam	1⅓ pt.	20 lb. (5%)	2 qt.	60 lb.
		Soybeans		
Amiben	2 qt.	10 lb. (10%)	1½ gal.	30 lb.
Treflan	⅙-⅓ qt.	3⅓-7 lb. (5%)	½-1 qt.	10-20 lb.
Randox	1⅓ qt.	7 lb. (20%)	4 qt.	20 lb.
Ramrod[d]	2 lb.	7 lb. (20%)	6 lb.	20 lb.
Alanap Plus	2 qt.	14 lb. (12.5%)	1½ gal.	40 lb.
Lorox[e]	⅓-⅔ lb.	......	1-2 lb.	....
Vernam	½-⅔ qt.	7-10 lb. (10%)	1⅓-2 qt.	20-30 lb.
Planavin[e]	¼-⅓ qt.	......	¾-1 qt.	....

[a] For broadcasting use 10 to 30 gallons of spray solution per acre for liquid formulations. For wettable powders use 20 to 30 gallons of spray per acre.
[b] The amount of granules listed is for material with the indicated amount of active ingredients.
[c] For a 2,4-D formulation containing 4 pounds acid equivalent per gallon.
[d] For use only on soybeans raised for seed.
[e] Amount for light-colored silt loam. See label for rates on other soils.

Example: 12 inches ÷ 36 inches = ⅓ or 33 percent.

By operating your equipment over one acre of land you can determine how much spray is used. Do this by starting with a full tank of water and after operating on one acre measure the amount of water needed to refill the tank. Multiply the percentage figure from the guide above for your situation times the amount of herbicide recommended for broadcasting. The answer is the amount of herbicide to add with enough water to equal the spray volume you used per acre.

Example: 28-inch rows with 14-inch band; 1 gallon per acre of herbicide recommended if broadcast; 50 percent (from table) × 1 gallon = ½ gallon per acre needed for 14-inch bands on 28-inch rows; if you used 10 gallons per acre of spray, add ½ gallon of herbicide to each 9½ gallons of water to make 10 gallons of spray solution.

The amount of active chemical per row doesn't change with row spacings, but the amount of chemical applied per acre does. Table 3 below shows the liquid and granular band rates for 13-inch bands on various row widths.

Table 3. — Liquid and Granular Band Rates for 13-Inch Bands on Various Row Widths

Broadcast rate (gallons per acre)	40-inch rows	38-inch rows	36-inch rows	30-inch rows	20-inch rows
			Liquid (gallons per acre)		
15	4.9	5.1	5.4	6.5	9.8
20	6.5	6.8	7.2	8.7	13.0
25	8.1	8.5	9.0	10.8	16.2
30	9.8	10.3	10.8	13.0	19.5
			Granular (pounds per acre)		
	1	1.1	1.1	1.3	2.0
	2	2.1	2.2	2.7	4.0
	3	3.2	3.3	4.0	6.0
	4	4.2	4.4	5.3	8.0
	5	5.3	5.5	6.7	10.0
	6	6.3	6.7	8.0	12.0
	7	7.4	7.8	9.3	14.0
	8	8.4	8.9	10.7	16.0
	9	9.5	10.0	12.0	18.0
	10	10.5	11.1	13.3	20.0
	11	11.6	12.2	14.7	22.0
	12	12.6	13.3	16.0	24.0
	13	13.7	14.4	17.3	26.0
	14	14.8	15.5	18.7	28.0
	15	15.8	16.7	20.0	30.0
	16	16.9	17.8	21.3	32.0

NHE-90
Miscellaneous
1/1/69

Cooperative Extension Service
University of Illinois College of Agriculture in
Cooperation With the Illinois Natural History Survey
Urbana, Illinois

CHECK LIST OF INSECTICIDES

There are many insecticides listed in Circulars 897 (Commercial Vegetables), 898 (Livestock), 899 (Field Crops), and 900 (Homeowner) containing the current Illinois insecticide recommendations. The following list gives some information about these insecticides; we have also included other insecticides that have label approval but are not in the Illinois recommendations.

The insecticide names are listed at the left in capital letters. Usually these are the common names, but if they are trade names they are marked with an asterisk. Trade names and other identifying names follow the common names. The name of the basic manufacturer is listed after the trade name.

Toxicity ratings for each insecticide are listed below the name. An acute oral toxicity rating for each insecticide is given, also a dermal toxicity rating if known. Acute oral toxicity ratings are usually obtained by feeding white rats, acute dermal ratings by skin absorption tests on rats or rabbits. These figures are expressed as LD50. This means the size of the dose which is lethal to 50 percent of the test animals. LD50 is expressed in terms of milligrams of actual insecticide per kilogram of body weight of the test animal--mg./kg. Chronic oral toxicity (90 days plus) with the no-effect level in the diet is expressed in parts per million. When available, toxicity ratings of insecticides to fish and honeybees are also given. Those for bees can be interpreted readily as follows: (1) High--kills bees on contact and by residues; bees should be removed from area of application. (2) Moderate--kills bees if applied over them; limited damage with correct dosage, timing, and method of application. (3) Low--can be used around bees with few precautions and a minimum of injury.

To express toxicity in practical terms, the factor .003 times the LD50 value will give the ounces of actual insecticide required to be lethal to one of every two 187-pound men or other warm-blooded animals. As an example, the oral LD50 value for malathion is 1,200 mg./kg.; thus, if a group of men each weighing 187 pounds ate 3.6 ounces (1,200 times .003) of actual malathion per man, half of them would succumb. The dermal-toxicity-LD50 value of malathion is approximately 4,000 mg./kg. or for a 187-pound man, 12 ounces. If you check the list of insecticides, you will find some highly toxic chemicals with LD50 values from 1 to 10 mg./kg. For the average man, fatal doses of these would be in the range of .003 to .03 ounce.

By comparison, the oral LD50 value of aspirin is 1,200 mg./kg. or 3.6 ounces per 187-pound man, the equivalent of malathion. The oral LD50 value of ethyl alcohol is 4,500 mg./kg. If a group of 187-pound men each consumed somewhat more than 1 quart of 80 proof whiskey in 45 minutes they would not only be intoxicated, 50 percent of them might die.

It is important to remember that these toxicity ratings of each insecticide listed are approximate and pertain to white rats and sometimes rabbits. Such ratings do serve as a guide to compare the toxicity of insecticides as well as an indication of their comparative acute toxicity to other warm-blooded animals and man. Acute toxicity ratings expressed as LD50 are classified as to their relative danger when being used. An LD50 or 750 mg./kg. or higher is rated as low toxicity, LD50 ratings of 150-750 is moderate, 50-150 is moderately high, and 50 or less is very high.

The chemical group to which the insecticide belongs is given after the toxicity ratings. From this, you can determine which insecticides have similar chemical properties. A brief statement follows the chemical group name, describing in general terms the principal uses for the insecticide.

Remember, this is not a list of recommended insecticides, nor is it to be used in determining what insecticide to use to control a particular insect. This list is a quick insecticide reference to compare common chemical names to trade names, their toxicity ratings and general uses.

1969 REVISIONS

CHLOROPROPYLATE, also Acaralate

CRUFOMATE--see Ruelene

DASANIT--Label approved for control of soil insects in corn.

DURSBAN--also for mosquito control

FAMPHUR	Famophos, Warbex	American Cyanamid

Acute oral--35-62
Acute dermal--1,460-5,093
Chronic oral--1

Organic phosphate--A systemic insecticide used for controlling grubs in cattle.

ZINOPHOS*	Nemaphos, Nemafos	American Cyanamid

Acute oral--9-16
Acute dermal--8-15
Chronic oral-->5

Organic phosphate--A soil insecticide for control of garden symphylans and cabbage maggot.

*Trade name.

ABATE* American Cyanamid

Acute oral--1,000-3,000
Acute dermal--1,024-1,782
Chronic oral--2

Organic phosphate--Used as a larvicide for mosquito control.

ALDRIN Shell

Acute oral--39-60
Acute dermal--98
Chronic oral--0.5

Fish toxicity--Very high
Bee toxicity--High

Chlorinated hydrocarbon--Used as a soil insecticide for corn root insects and termites.

ALLETHRIN Synthetic pyrethrin, Pynamin FMC, Benzol Products

Acute oral--680-1,000
Acute dermal--11,200
Chronic oral--5,000

Bee toxicity--Low

Botanical--Used in household aerosols and fly sprays as a quick knockdown. No residual action.

APHOLATE Olin Mathieson

Acute oral--90
Acute dermal--50-200

Organic phosphate--Used as a chemical sterilizing agent of insects.

ARAMITE* U.S. Rubber

Acute oral--3,900
Chronic oral--500

Fish toxicity--Moderate
Bee toxicity--Low

Sulfonate--Miticide limited to ornamentals and household. No clearance on fruit or vegetables, has carcinogenic properties.

AZINPHOSMETHYL Guthion Chemagro

Acute oral--11-13
Acute dermal--220
Chronic oral--5

Bee toxicity--High

Organic phosphate--Used on cotton, forage crops, and on tree fruit to control both insects and mites.

* Trade name.

AZODRIN* SD 9129 Shell

Acute oral--21
Acute dermal--354
Chronic oral--1

Bee toxicity--High

Organic phosphate: Systemic insecticide for use on cotton and fruit crops upon label approval.

BACILLUS POPILLIAE

Bacterial--Nontoxic microbial insecticide. Applied to soil to infect Japanese beetle grubs with milky disease.

BACILLUS THURINGIENSIS Thuricide, Agritrol, Larvatrol

Bee toxicity--Low

Bacterial--A nontoxic microbial insecticide used to control caterpillars on vegetable crops and forest trees.

BAYGON propoxur Chemagro

Acute oral--95-104
Acute dermal--1,000+
Chronic oral--800

Carbamate--For use by pest control operators only against mosquitoes, household insects, and certain lawn insects.

BAYTEX*--see fenthion

BENZENE HEXACHLORIDE BHC, gammexane Diamond Alkali, Hooker, Olin Mathieson, Stauffer

Acute oral--1,250
Chronic oral--10

Bee toxicity--High

Chlorinated hydrocarbon--Limited use; replaced by lindane.

BENZYL BENZOATE Monsanto

Acute oral--500-5,000

Repellent--A repellent for chiggers, mosquitoes, and ticks on man.

BIDRIN* Shell

Acute oral--22
Acute dermal--225
Chronic oral--1

Bee toxicity--High

Organic phosphate--Highly toxic systemic insecticide used for mimosa webworm control on honey locust. Recommended in many states as an injected systemic for elm bark beetle control but to be applied only by people especially trained to do the work.

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* Trade name.

BINAPACRYL | Morocide, Acricid | FMC

Acute oral--161
Acute dermal--1,350

Bee toxicity--Low

Nitrophenol--A miticide for certain fruit crops.

BUXTEN* | Ortho 5353 | Chevron

Acute oral--87
Acute dermal--400

Carbamate--Used for soil insect control in corn.

BUTOXY POLYPROPYLENE GLYCOL | Crag Fly Repellent | Union Carbide

Acute oral--9,100-11,200
Chronic oral--640

Repellent--Used in sprays for cattle against flies.

CARBARYL | Sevin | Union Carbide

Acute oral--500-850
Acute dermal--4,000+
Chronic oral--200

Fish toxicity--Very low
Bee toxicity--High

Carbamate--A general insecticide registered for control of many pests of field crops, vegetables, fruit, homeowner, and livestock.

CARBON DISULFIDE | Stauffer

Chronic vapor--20 ppm. (40 hr.)
Acute vapor--200 ppm. (1 hr.)

Fumigant--Used on stored products.

CARBON TETRACHLORIDE | Allied, Diamond Alkali, Dow, FMC, Frontier, Stauffer

Acute oral--5,730-9,770
Acute dermal--5,070-8,780
Chronic vapor--10 ppm. (40 hr.)
Acute vapor--300 ppm. (1 hr.)

Fumigant--Used as safener in fumigant mixtures for stored grain insects.

CARBOPHENOTHION | Trithion, Garrathion | Stauffer

Acute oral--10-30
Acute dermal--27-54
Chronic oral--5

Bee toxicity--Moderate

Organic phosphate--Insecticide with lasting residue with limited use on some fruits and vegetables. It is used chiefly as a miticide.

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* Trade name.

CHLORBENSIDE — Mitox — Chevron

Acute oral--3,000
Chronic oral--20

Bee toxicity--Low

Organic sulfide--A miticide used on many fruit crops.

CHLORDANE — Octachlor, Octa-Klor — Velsicol

Acute oral--335-430
Acute dermal--690-840
Chronic oral--25+

Fish toxicity--Very high
Bee toxicity--High

Chlorinated hydrocarbon--A residual insecticide for control of ants and roaches and a soil insecticide for termites, lawn, and corn soil insects. Has some uses on fruits and vegetables.

CHLOROBENZILATE — Geigy

Acute oral--1,040-1,220
Acute dermal--5,000+

Bee toxicity--Moderate

Chlorinated hydrocarbon--A comparatively safe miticide used in orchards and greenhouses.

CHLOROPICRIN — Picfume — Dow, Morton

Chronic vapor--0.1 ppm. (40 hr.)
Acute vapor--20 ppm. (1 hr.)

Fumigant--Used on stored products in ship holds.

CHLOROPROPYLATE — Geigy

Acute oral--34,600
Acute dermal--10,200

Bee toxicity--Low

Chlorinated hydrocarbon--Miticide for fruit crops.

CIODRIN* — SD 4294 — Shell

Acute oral--125
Acute dermal--385
Chronic oral--7

Bee toxicity--High

Organic phosphate--Used to control livestock insects, especially biting flies.

COMPOUND 4072 — SD 7859 — Allied, Shell

Acute oral--13
Acute dermal--30

Organic phosphate--A residual insecticide for fly control in livestock barns and as a soil insecticide in corn.

CO-RAL*--see coumaphos

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* Trade name.

COUMAPHOS — Co-Ral — Chemagro

Acute oral--15-41
Acute dermal--860
Chronic oral--5

Bee toxicity--Moderate

Organic phosphate--A systemic insecticide for beef cattle and poultry to control grubs, lice, and mites.

CYGON*--see dimethoate

DASANIT* — Bayer 25141 — Chemagro

Acute oral--2-11
Acute dermal--3-30

Organic phosphate--Experimental insecticide and nematocide for possible use for soil insect control in corn.

DDD*--see TDE

DDT — Allied, Diamond Alkali, Geigy, Lebanon, Montrose, Olin Mathieson, Stauffer

Acute oral--113-118
Acute dermal--2,510
Chronic oral--5

Fish toxicity--Very high
Bee toxicity--Moderate

Chlorinated hydrocarbon--A general insecticide registered for use on some field, vegetable, and fruit crops. Also for control for certain livestock insects.

DDVP*--see dichlorvos

DEET — Off, Delphene, diethyltoluamide — Hercules

Acute oral--1,950
Acute dermal--10,000

Repellent--Used for control of biting insects and chiggers on man. Applied directly to skin.

DELNAV*--see dioxathion

DEMETON — Systox — Chemagro

Acute oral--2-6
Acute dermal--8-14
Chronic oral--1

Fish toxicity--Moderate
Bee toxicity--Low

Organic phosphate--A systemic miticide and aphicide for use in greenhouses, orchards, and on certain field crops.

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* Trade name.

DESSIN* — Murphy, Union Carbide

Acute oral--100-155
Acute dermal--1,000

Carbonate--Miticide for fruit crops.

DIAZINON — Geigy

Acute oral--76-108 — Fish toxicity--High
Acute dermal--455-900 — Bee toxicity--High
Chronic oral--1

Organic phosphate--A general insecticide; can be used as a residual fly spray in barns, also to control insects in soil of cornfields, as well as insect pests of vegetables, fruits, and household.

DIBROM*--see naled

DIBUTYL PHTHALATE — DBP — Allied, Monsanto, Commercial Solvent

Acute oral--5,000-15,000

Repellent--For impregnating clothing to repel chiggers and mites.

DICHLORVOS — DDVP, Vapona — Shell

Acute oral--56-80 — Fish toxicity--Moderate
Acute dermal--75-107 — Bee toxicity--High

Organic phosphate--Short-lived residual insecticide for livestock, fly bait, greenhouses, and warehouses.

DICOFOL — Kelthane — Rohm and Haas

Acute oral--1,000-1,100 — Fish toxicity--High
Acute dermal--1,000-1,230 — Bee toxicity--Low
Chronic oral--20

Chlorinated hydrocarbon--Miticide used on vegetables, fruit, and ornamentals.

DIELDRIN — Octalox — Shell

Acute oral--46 — Fish toxicity--Very high
Acute dermal--60-90 — Bee toxicity--High
Chronic oral--0.5

Chlorinated hydrocarbon--Used as a seed treatment insecticide and for control of specific fruit insects, lawn soil insects, termites and household insects.

DIMETHOATE — Cygon, Rogor, Roxion — American Cyanamid

Acute oral--215 — Fish toxicity--Very low
Acute dermal--400-610 — Bee toxicity--High
Chronic oral--5

Organic phosphate--A systemic insecticide for use on certain vegetable crops and residual fly spray inside of livestock barns.

* Trade name.

DIMETHYL PHTHALATE | DMP | Monsanto, Allied

Acute oral--8,200
Acute dermal--4,000+

Repellent--General purpose mosquito repellent.

DIMETILAN* | SNIP | Geigy

Acute oral--25-64 | Bee toxicity--Moderate
Acute dermal--600+

Carbamate--Insecticide impregnated on plastic foam bands for fly control in livestock buildings.

DINITRO COMPOUNDS | (Elgetol, DN, DNBP, DNOC) | Dow, FMC, Chem. Ins. Corp.

Acute oral--5-60 | Bee toxicity DN-111--Low
Acute dermal--150-600 | DNOSBP--High

Nitrophenol--Used primarily for controlling aphids as dormant fruit spray.

DINOCAP | Karathane | Rohm and Haas

Acute oral--980-1,190
Acute dermal--4,700-9,400

Dinitro--A fungicide used for control of powdery mildew; also acts as a mite suppressant.

DIOXATHION | Delnav, Navadel | Hercules

Acute oral--23-43 | Bee toxicity--Low
Acute dermal--63-235
Chronic oral--4

Organic phosphate--Miticide and insecticide used as an animal dip and spray.

DIPTEREX*--see trichlorfon

DISULFOTON | Di-Syston, dithiodemeton, thiodemeton | Chemagro

Acute oral--2-7 | Bee toxicity--Moderate
Acute dermal--6-15
Chronic oral--2

Organic phosphate--A systemic insecticide to control aphids, leafhoppers, and flea beetles on certain vegetable crops. Also a soil insecticide for corn.

DI-SYSTON*--see disulfoton

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* Trade name.

DURSBAN* Dowco 179 Dow

Acute oral--97-276
Acute dermal--2,000

Organic phosphate--Used as a soil insecticide in corn.

DYFONATE N2790 Stauffer

Acute oral--16

Organic phosphate--Used for soil insect control in corn.

DYLOX*--see trichlorfon

ENDOSULFAN Thiodan, Malix FMC

Acute oral--18-43
Acute dermal--74-130
Chronic oral--30

Bee toxicity--Moderate

Chlorinated hydrocarbon--Used on some vegetable crops to control aphids, cabbage worms, and other caterpillars. Also used for borer control on peach trees.

ENDRIN Shell, Velsicol

Acute oral--8-18
Acute dermal--15-18
Chronic oral--1

Fish toxicity--Very high
Bee toxicity--Moderate

Chlorinated hydrocarbon--Highly toxic residual insecticide used on some field crops and ornamentals.

ENTEX*--see fenthion

EPN DuPont

Acute oral--8-36
Acute dermal--25-230

Bee toxicity--High

Organic phosphate--Used mostly on fruit insects as an insecticide and miticide.

ETHION Nialate FMC

Acute oral--27-65
Acute dermal--62-245
Chronic oral--3

Bee toxicity--Low

Organic phosphate--Used for onion maggot control, aphids and mite control in orchards.

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* Trade name.

ETHYLENE DIBROMIDE — American Potash, Dow, FMC, Great Lakes, Michigan Chemical

Acute oral--117-146
Acute dermal--300
Chronic vapor--25 ppm. (40 hr.)
Acute vapor--200 ppm. (1 hr.)

Fumigant--Used on stored products.

ETHYLENE DICHLORIDE — Diamond Alkali, Dow, Olin Mathieson

Acute oral--770
Acute dermal--3,890
Chronic vapor--50 ppm. (40 hr.)
Acute vapor--1,000 ppm. (1 hr.)

Fumigant--Used on stored grains.

EUGENOL — Penick

Acute oral--500-5,000

Attractant--Used for attracting fruit flies.

FENTHION — Baytex, Entex — Chemagro

Acute oral--215-245
Acute dermal--330
Chronic oral--2

Fish toxicity--Low
Bee toxicity--High

Organic phosphate--Residual fly spray for livestock barns. Used in mosquito control and for household insects.

FURADAN* — NIA 10242 — Niagara, FMC

Acute oral--5
Acute dermal--885

Carbamate--Experimental insecticide for possible use on corn soil insects and alfalfa weevil.

GARDONA* — SD 8447 — Shell

Acute oral--4,000-5,000
Acute dermal--5,000+

Organic phosphate--Used for earworm control on seed corn only.

GERANIOL — Fritzche

Attractant--Used as an attractant in traps for Japanese beetle.

GUTHION*--see azinphosmethyl

* Trade name.

GYPLURE USDA

Attractant--Used as an attractant for gypsy moths.

HEMPA Eastman, Chemical Products

Acute oral LD 100--2,640

Organic phosphate--Used as a chemical sterilizing agent of insects.

HEPTACHLOR Velsicol

Acute oral--100-162
Acute dermal--195-250
Chronic oral--0.5-5

Fish toxicity--Very high
Bee toxicity--High

Chlorinated hydrocarbon--Used as corn seed treatment, soil insecticide for corn insects and termites.

HYDROCYANIC ACID HCN American Cyanamid

Acute oral--4
Chronic vapor--10 ppm. (40 hr.)
Acute vapor--40 ppm. (1 hr.)

Fumigant--Used on stored products and for rodent control and building fumigation.

IMIDAN* R-1504, Prolate Stauffer

Acute oral--147-216
Acute dermal--3,160

Organic phosphate--Experimental insecticide for possible use for soil insect control in corn, for fruit insect control, and against certain foliar insects.

KARATHANE*--see dinocap

KELTHANE*--see dicofol

Chlorinated hydrocarbon--Miticide to be used on vegetables, fruits, and ornamentals.

KEPONE* Allied

Acute oral--125
Acute dermal--2,000+

Chlorinated hydrocarbon--Used in baits to control ants, roaches, and certain other insects.

KORLAN*--see ronnel

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* Trade name.

LANDRIN* SD 8530 Shell

Acute oral--103-178
Acute dermal--2,500

Carbamate--Experimental insecticide for possible use for soil insect control in corn.

LANNATE* 1179 DuPont

Acute oral--17-24
Acute dermal-->1,500

Carbamate--Experimental insecticide for possible use against a wide variety of foliar feeding insects and for soil insect control in corn.

LEAD ARSENATE

Acute oral--1,050 Bee toxicity--High
Acute dermal--2,400+

Arsenical--Used to control certain chewing insects of fruit and ornamentals.

LETHANE 60* Rohm and Haas

Acute oral--250-500
Acute dermal--3,000

Thiocyanate--Used in household insecticide sprays.

LETHANE 384* Rohm and Haas

Acute oral--90
Acute dermal--250-500

Thiocyanate--Used in livestock fly sprays as a quick knockdown agent.

LINDANE gamma BHC Hooker

Acute oral--88-91 Fish toxicity--Very high
Acute dermal--900-1,000 Bee toxicity--High
Chronic oral--50

Chlorinated hydrocarbon--Used to control spittlebugs on certain crops and mite and louse control on certain livestock.

MALATHION American Cyanamid

Acute oral--1,000-1,375 Fish toxicity--High
Acute dermal--4,444+ Bee toxicity--High
Chronic oral--100-1,000

Organic phosphate--General use insecticide for homeowner insect control, for certain livestock insects and certain crop insects. Premium grade used for treating grain to be stored.

* Trade name.

METALDEHYDE

Acute oral--1,000

Attractant--Used in combination with stomach poisons for snail and slug baits.

META-SYSTOX R*--see oxydemetonmethyl

METEPA | Metaphoxide, Methyl Aphoxide | American Cyanamid

Acute oral--93-277
Acute dermal--156-214

Organic phosphate--Used as a chemical sterilizing agent of insects.

METHOXYCHLOR | Marlate | DuPont, Geigy

Acute oral--5,000
Acute dermal--6,000+
Chronic oral--100

Fish toxicity--Very high
Bee toxicity--Low

Chlorinated hydrocarbon--Used in many homeowner fruit and vegetable spray or dust mixtures and for certain field crop insects.

METHYL BROMIDE | bromomethane | American Potash, Dow, Frontier, Great Lakes, Michigan Chemical

Chronic vapor--20 ppm. (40 hr.)
Acute vapor--200 ppm. (1 hr.)

Fumigant--Used on stored products.

METHYL PARATHION | Metacide, Nitrox, Metron | American Potash, Monsanto, Shell, Stauffer, Velsicol

Acute oral--14-24
Acute dermal--67

Fish toxicity--Very low
Bee toxicity--High

Organic phosphate--It is closely related to parathion and is used primarily for insect control on cotton.

METHYL TRITHION* | Stauffer

Acute oral--98-120
Acute dermal--190-215

Bee toxicity--High

Organic phosphate--It is closely related to trithion or carbophenothion. It is a residual insecticide used in both insect and mite control on certain fruits and vegetables.

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* Trade name.

MEVINPHOS Phosdrin Shell

Acute oral--4-6
Acute dermal--4-5
Chronic oral--0.8

Bee toxicity--High

Organic phosphate--Very toxic, short-lived residual insecticide for control of insects on certain field and vegetable crops.

MGK-R11* MGK

Acute oral--2,500
Acute dermal--2,000+

Repellent--Used in sprays for cattle against flies.

MGK-R326* MGK

Acute oral--5,230-7,230
Acute dermal--9,400

Repellent--Used in sprays for cattle against flies.

MIREX Allied

Acute oral--600-740
Acute dermal--2,000+

Bee toxicity--Moderate

Chlorinated hydrocarbon--Used for fire ant control and certain insects of vegetable crops.

MOBAM* MCA600 Mobil

Aucte oral--234
Acute dermal--6,230
Chronic--150

Carbamate--Experimental insecticide for possible use on soil insects in corn, for insects on ornamentals, and for household insects.

MOCAP* VC9104 Mobil

Acute oral--62
Acute dermal--26

Phosphate--Experimental residual chemical for possible control of soil insects and nematodes.

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* Trade name.

MORESTAN* Chemagro

Acute oral--1,100-1,800
Acute dermal--2,000+
Chronic oral--50

Bee toxicity--Low

Organic carbonate--Miticide to be used on apples prior to bloom.

MOROCIDE*--see binapacryl

NALED Dibrom Chevron

Acute oral--250
Acute dermal--800

Fish toxicity--High
Bee toxicity--High

Organic phosphate--A short-lived residual insecticide for use in greenhouses and for certain field crops. Also used in fly baits in livestock barns.

NEGUVON*--see trichlorfon

NICOTINE Black Leaf 40, Nicotine Sulfate Center Chemical, Inc.

Acute oral--83
Acute dermal--285

Bee toxicity--Low

Heterocyclic botanical compound--Contact insecticide that is used to control aphids.

OVEX Ovotran, Chlorofenson, Ovochlor Dow, Murphy

Acute oral--2,050
Chronic oral--25

Fish toxicity--Low
Bee toxicity--Low

Sulfonate--Used to destroy mite eggs on certain fruit and vegetable crops and ornamentals.

OXYDEMETONMETHYL Meta-Systox R Chemagro

Acute oral--65-75
Acute dermal--250
Chronic oral--10

Bee toxicity--Moderate

Organic phosphate--A systemic insecticide for controlling aphids, mites, and other plant-sucking insects.

PARADICHLOROBENZENE PDB, Paracide Dow, Monsanto

Acute oral--1,000+

Fumigant--Used as fumigant to control fabric pests. Obsolete for peach borer control.

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* Trade name.

PARATHION — Alkron, Niran, Stathion, Thiophos — American Cyanamid, American Potash, Monsanto, Shell, Stauffer, Velsicol

Acute oral--4-13
Acute dermal--7-21
Chronic oral--1

Fish toxicity--High
Bee toxicity--High

Organic phosphate--A highly toxic insecticide to control a wide range of insects and mites on vegetable, fruit, and field crops.

PENTAC* — HRS-16 — Hooker

Acute oral--3,160
Acute dermal--3,160+

Bee toxicity--Low

Chlorinated hydrocarbon--Miticide used on greenhouse floral crops and nursery stock.

PERTHANE* — Rohm and Haas

Acute oral--4,000+
Chronic oral--500

Fish toxicity--Very high
Bee toxicity--Moderate

Chlorinated hydrocarbon--Used in formulating household insecticides and also used on certain vegetable crops.

PHORATE — Thimet — American Cyanamid

Acute oral--1-3
Acute dermal--3-6

Bee toxicity--Moderate

Organic phosphate--A highly toxic systemic insecticide for use on certain vegetable crops, field crops, and as a soil insecticide for corn.

PHOSDRIN*--see mevinphos

PHOSPHAMIDON — Dimecron — Chevron

Acute oral--24
Acute dermal--107-143

Fish toxicity--Very low
Bee toxicity--High

Organic phosphate--A systemic insecticide for use on certain fruit and vegetable crops.

PIPERONYL BUTOXIDE — Butocide — FMC

Acute oral--7,500+
Acute dermal--1,880
Chronic oral--1,000

Synergist--Commonly used with pyrethrum.

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* Trade name.

PYRETHRUM   pyrethrin I and II   FMC, Penick

Acute oral--820-1,870
Acute dermal--1,880+
Chronic oral--1,000

Fish toxicity--High
Bee toxicity--Low

Botanical--Used as a fly control insecticide in household and livestock sprays.

RONNEL   Korlan, Trolene, Viozene   Dow

Acute oral--1,250-2,630
Acute dermal--5,000+
Chronic oral--10

Bee toxicity--Moderate

Organic phosphate--Used in baits and sprays for fly control in livestock barns.

ROTENONE   derris, cube   FMC, Penick

Acute oral--50-75
Acute dermal--940+
Chronic oral--25

Fish toxicity--Very high
Bee toxicity--Low

Botanical--A contact poison used to control certain home garden insects and cattle grubs.

RUELENE*   Dowcoe 132   Dow

Acute oral--460-635
Acute dermal--2,000-4,000
Chronic oral--10-30

Organic phosphate--A systemic insecticide for controlling grubs and lice on beef cattle.

SEVIN*--see carbaryl

STROBANE   3961   Heyden

Acute oral--200
Acute dermal--5,000+

Fish toxicity--Very high
Bee toxicity--Low

Chlorinated hydrocarbon--Used for certain cotton insect control and is sometimes used for fly control in livestock barns.

SULFOXIDE   Sulfox-Cide   Penick

Acute oral--2,000
Acute dermal--9,000+
Chronic oral--2,000

Synergist--Commonly used with pyrethrum.

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* Trade name.

SYSTOX*--see demeton

TDE | DDD, Rhothane | Allied, Rohm and Haas

Acute oral--4,000+
Acute dermal--4,000+
Chronic oral--100

Fish toxicity--Very high
Bee toxicity--Moderate

Chlorinated hydrocarbon--A DDT related compound used to control leaf rollers, tobacco hornworm, and tomato fruitworm.

TEDION*--see tetradifon

TEMIK* | UC 21149 | Union Carbide

Acute oral--5-10
Acute dermal--1,400

Carbamate--Experimental residual, systemic insecticide and miticide for possible use against mites and certain insects of fruits, vegetables, and ornamentals.

TEPA | Aphoxide | Dow

Acute oral--126-252

Organic phosphate--Used as a chemical sterilizing agent of insects.

TEPP | Vapatone, Tetron | American Potash

Acute oral--1
Acute dermal--2

Bee toxicity--High

Organic phosphate--A highly toxic, short-lived insecticide for the control of aphids and mites on fruit, vegetable, and forage crops.

TETRADIFON | Tedion | Niagara, Phillips

Acute oral--14,700+
Acute dermal--10,000+

Bee toxicity--Low

Sulfonate--A miticide for fruit crops.

THANITE* | | Hercules

Acute oral--1,600
Acute dermal--6,000

Thiocyanate--It is added to household and livestock sprays to increase knockdown of flying insects.

THIMET*--see phorate

* Trade name.

THIODAN*--see endosulfan

THUROCIDE*--see bacillus thuringiensis

TOXAPHENE chlorinated camphene Hercules

Acute oral--80-90
Acute dermal--780-1,075
Chronic oral--10

Fish toxicity--Very high
Bee toxicity--Low

Chlorinated hydrocarbon--Used to control many insects of grain and forage crops, livestock, vegetable, and fruit crops. Use in backrubbers and as a sheep dip.

TRICHLORFON Dylox, Dipterex, Neguvon Chemagro

Acute oral--560-630
Acute dermal--2,000+

Fish toxicity--Very low
Bee toxicity--Low

Organic phosphate--Dipterex used in fly baits and Dylox as a spray for certain field crops, vegetable and ornamental insects.

TRITHION*--see carbophenothion

VAPATONE*--see TEPP

VAPONA*--see dichlorvos

WARF antiresistant for DDT* Penick

Acute oral--500
Acute dermal--9,400

Sulfonamide--Used with DDT as a residual spray against DDT resistant and nonresistant flies.

ZECTRAN* Dowco 139 Dow

Acute oral--25-37
Acute dermal--1,500-2,500

Fish toxicity--Very low
Bee toxicity--High

Carbamate--Used for ornamentals and turf insect control, also for control of slugs.

* Trade name.

Prepared by entomologists of the Illinois Agricultural Extension Service and Illinois Natural History Survey. For additional copies, see your county farm adviser.

Urbana, Illinois January, 1969
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101 YEARS AGO
IN ENTOMOLOGY

Quotes from the First Annual Report of State Entomologist, 1868, on Noxious Insects:

"All Underground insects are peculiarly difficult to combat, first, because the mischief done by them is generally discovered too late for any remedy to be applied, and second, because entomologists know less of the natural history of this group of insects than of that of almost any other group, owing to their being so secluded from observation and experiment within the bowels of the earth."

"Upon the whole the Paris-green, if properly used, may be considered to be an almost infallible remedy against the Colorado Potato beetle, and many other leaf-eating insects. Any harm from its use, either to the plants or the operator, can be obviated by observing the following rules:

1. Always dilute the poison with at least ten times its bulk of flour.
2. Apply it to the plants when wet with rain or dew.
3. Never entrust its use to young or careless persons.
4. Never use it near the house where young children resort.
5. Apply it with a gauze bag or some other sifter, attached to the end of a pole.
6. Let the operator always keep upon the side from which the wind is blowing.
7. Do not apply it to any plant where it will come in contact with the fruit."

"Washington County, Illinois, September 3, 1867.--THE FLYING GRASSHOPPERS are here by the bushel; voracious eaters, they make fruit-trees, groves, currant and gooseberry bushes, and potato vines look bad indeed. Corn-fields look like fields of bean-poles with ears on them." In *Prairie Farmer*, September 7, 1867.